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THE STATE OF OUR ENVIRONMENT

COMMONWEALTH OF MASSACHUSETTS

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

A P R I L 2 0 0 0

Earth Day, 2000

Dear Friend of the Environment:

We are pleased to present to you this comprehensive report, *The State of Our Environment*. It provides a historical look at the wonderfully diverse landscape of Massachusetts, examines the human impact on our resources, and explores what we can do to improve our environment.

Through government action, we have made great strides over the past ten years. We have protected more than 100,000 acres of open space; closed 105 unlined landfills; signed the nation's first Rivers Protection Act; reduced the release of toxic chemicals by 80%; privatized the state's hazardous-waste-cleanup system; and signed the innovative Brownfields Act to expedite the remediation and redevelopment of contaminated sites. These are accomplishments of which we can all be proud.

We must, however, look ahead and work together to address the environmental challenges of the 21st century. We must continue to work aggressively to ensure that Massachusetts has clean air and clean water. We must work to slow the effects of global warming. We must work to reduce the toxicity of the wastes we generate. At this time of unbridled development, it is more important than ever that we advance our goal of protecting another 200,000 acres of land by the year 2010.

This report provides us with a starting point from which we must all act to preserve the special character of Massachusetts. As you read through it, think about what you can do to better protect our environment and improve our quality of life in Massachusetts.

Sincerely,

Argeo Paul Cellucci
Governor

Jane Swift
Lieutenant Governor

AN INTRODUCTION FROM SECRETARY BOB DURAND

Environmentalism is a kind of stewardship, for the choices we make today about how to use our land and our natural resources will have major consequences for generations to come. In order to preserve the unique character of Massachusetts we need to better understand the relationship between ourselves and the natural and built environment. The way we build our homes and pave our roads, the way we farm and fish, how and what we manufacture and the goods we purchase – all have significant impacts on the environment and our quality of life.

The challenge for us all, then, is to preserve and enhance the environmental health of Massachusetts. To do this, we must make sure that all of our state environmental policies and programs continue to be guided by three basic principles: *to protect, to restore*, and *to sustain*.

First, we must *protect* our resources against future damage. To do this, we must continue to advance tough laws, regulations, and policies that protect public health and the environment. It is not enough for us to set protective rules; we also have a duty to enforce them strongly. These are the standards that we all must adhere to, ensuring that our actions do not degrade our natural resources or threaten public health.

Second, we must *restore* what has been damaged in the past. Although protective regulatory measures have significantly reduced harm to the environment, we recognize that past actions have left lasting scars across our landscape. We must strive to bring back many of the resources we have lost. This is no easy task, but it can be done, and we are committed to doing it.

Third, we must move toward *sustainability*. We must find new ways to reward and invest in those practices that promote pollution prevention and resource conservation. This means creating new incentives for businesses to do right by the environment, as well as using the state's purchasing power to buy green products and utilize innovative technologies.

But as important as government intervention is and will continue to be, our greatest hope for the future of the environment lies with our children. We must instill in our young people a strong environmental ethic, for they are the future stewards of the Massachusetts landscape and the unique resources it supports. For this reason, I have made environmental education a priority for Environmental Affairs. As Secretary,

I have visited 30 schools over the past year, and I have challenged the 3,500 employees throughout our agencies to volunteer in the classroom. We are working with the Department of Education to incorporate environmental education into the curriculum frameworks. Last December, we awarded the first outdoor classroom grants to schools in an effort to reconnect kids with the greatest teacher of all - nature.

This report, *The State of Our Environment,* is an integral part of our effort to better inform everyone in our Commonwealth, from schoolchildren to adults, about the natural world in which we live. This document will help citizens familiarize themselves with the major environmental issues facing Massachusetts today. Once people develop an appreciation for the environment, they come to better understand the everyday impacts and stresses we all place on the resources surrounding us. With this understanding, people are inspired to minimize these impacts and work to restore those resources that have deteriorated over time.

Each and every one of us can have a positive influence on our environment. Citizens can recycle and compost most household waste, and make sure that batteries, paints and other hazardous substances are disposed of properly. Citizens can form or join local land trusts to buy fields and forests, protecting open space in each individual community. Citizens can catalogue the plant and animal species in their community. Citizens can get out and monitor the water quality of nearby rivers and streams, or certify a vernal pool. Citizens can participate in Community Preservation efforts, uniting to form a consensus vision of how their city or town should plan for development, protect open space for the future, and preserve community character.

So here is our report to you on the state of the Massachusetts environment at the start of a new millennium. Use this report vigorously, thumb through it, study it, mark it up, make copies of it, and ask questions. While we have attempted to include the best information available, we acknowledge that we all have much more to learn about the environment and our effects upon it. The purpose of this report is not to convince you that state government is solving all of our problems – it's to show you that we all need to get involved, in both big and small ways. We all can make a difference in improving the state of our environment, for ourselves, for our future, and for our children.

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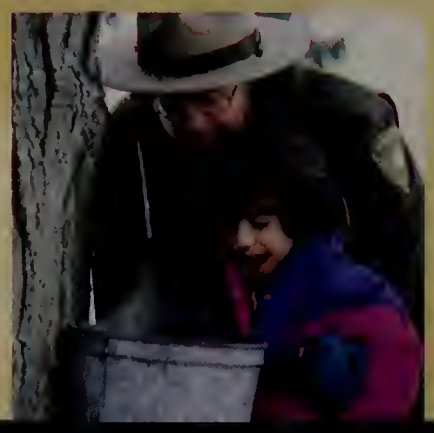
1.

GLACIERS, FORESTS, AND PEOPLE

THE HISTORY OF

THE MASSACHUSETTS

ENVIRONMENT



The Massachusetts environment
is an interplay between natural forces
and human communities.
Millions of years of mountain building
and erosion, the advance and retreat of
glaciers and forests, and the continuing
evolution of plant and animal species have shaped
the natural landscape.
The presence or absence of certain resources
helped determine what kinds of
human communities would develop.

At the same time, the present shape of
the Massachusetts landscape, from
its forests to its fields to its cities,
reflects the different human communities
that have developed here.
This human history has passed through three stages,
each of which has affected the environment
in distinctive ways:

THE EXTRACTIVE ECONOMY (8000 BC – 1800)

Forests gave way to fields, as farming villages spread
across the entire state by 1800. Fishing, whaling,
and trade supported wealthy seaports.

THE INDUSTRIAL ECONOMY (1800 – 1950)

The machine gave rise to the mill, the railroad,
and the large dense city. In reaction, America's first
environmental movement emerged around 1900.

THE INFORMATION ECONOMY (1950 – TODAY)

Today the forces of change are the computer,
the car, and the expanding suburbs.
We are challenged to strike a sustainable balance
between economic growth and
environmental protection and restoration.

1.

MOUNTAINS AND GLACIERS

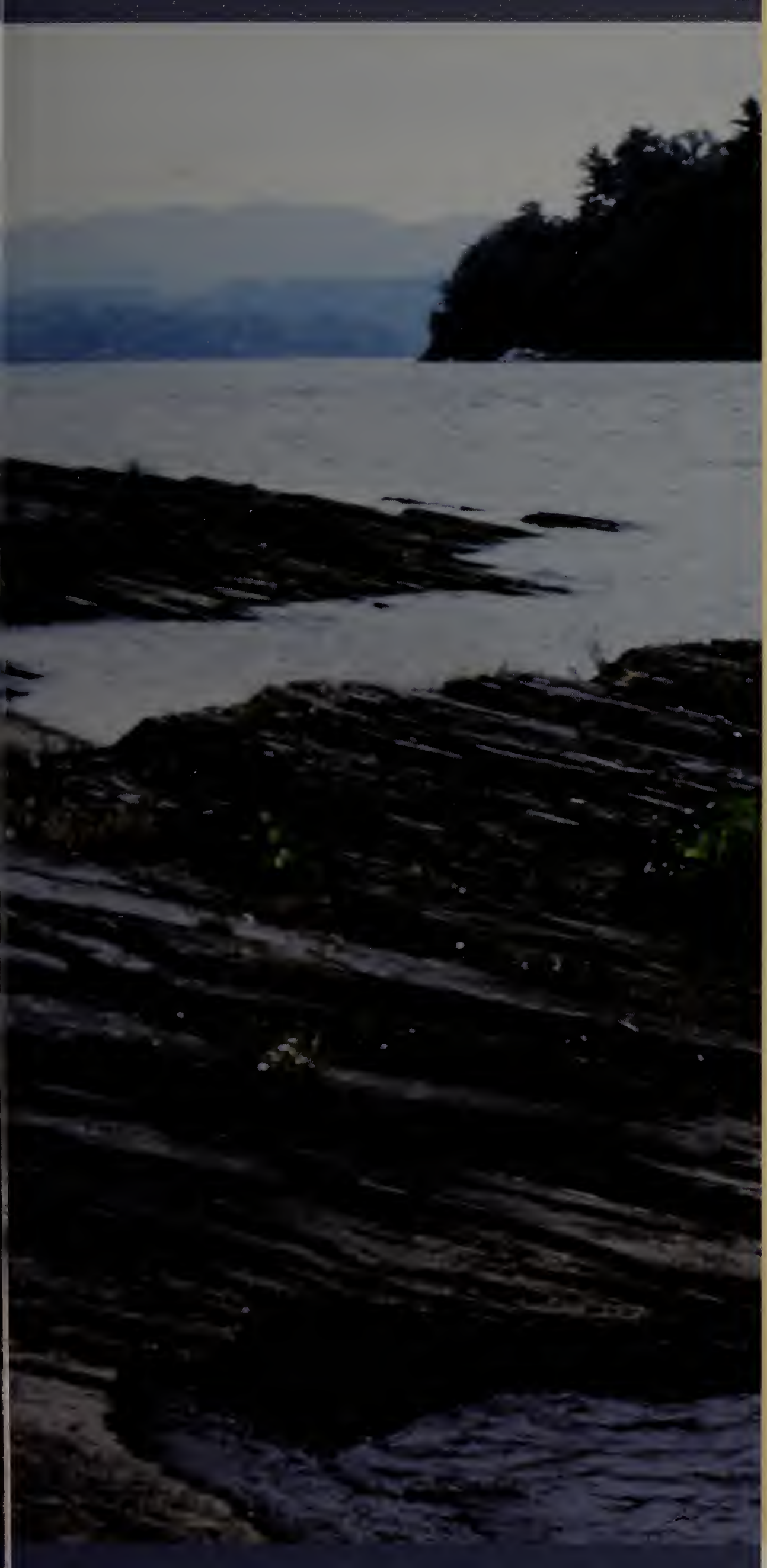
Over hundreds of millions of years, North America and Europe have collided several times, crumpling New England into a series of mountain chains that run roughly north/south. This topography has shaped our rivers and watersheds and helped determine the distribution of wildlife into different ecoregions.

The Berkshires are our oldest mountains. Formed over 500 million years ago, they are part of an ancient chain that continues north into Vermont's Green Mountains. Eons of erosion have worn down their gentle slopes, which today stand only 1,500 to 2,000 feet high. To their west is the more rugged Taconic Range, 450 million years old, which straddles the New York and Vermont borders. Here one finds our tallest peak, Mount Greylock, which is 3,491 feet high.

Descending into the Connecticut Valley one finds a very different geology: red sandstone, made of hardened silt that was deposited 180 million years ago during the age of the dinosaurs, on the floors of ancient lakes and riverbeds. Upwellings of lava within the valley created Mount Tom and Mount Holyoke.

NATURAL FORCES SHAPE THE LAND

This Connecticut River landscape, with 180-million-year-old Triassic sandstone, shows the shaping power of rockbuilding, glaciers, and water. (Photo: DFW)



Continuing east, isolated granite hills, the tallest being the 2,000-foot peak of Mount Wachusett, rise from the rolling uplands of the Worcester Plateau. These hills are outliers of the White Mountains, New England's youngest mountain range, which were formed 320 million years ago.

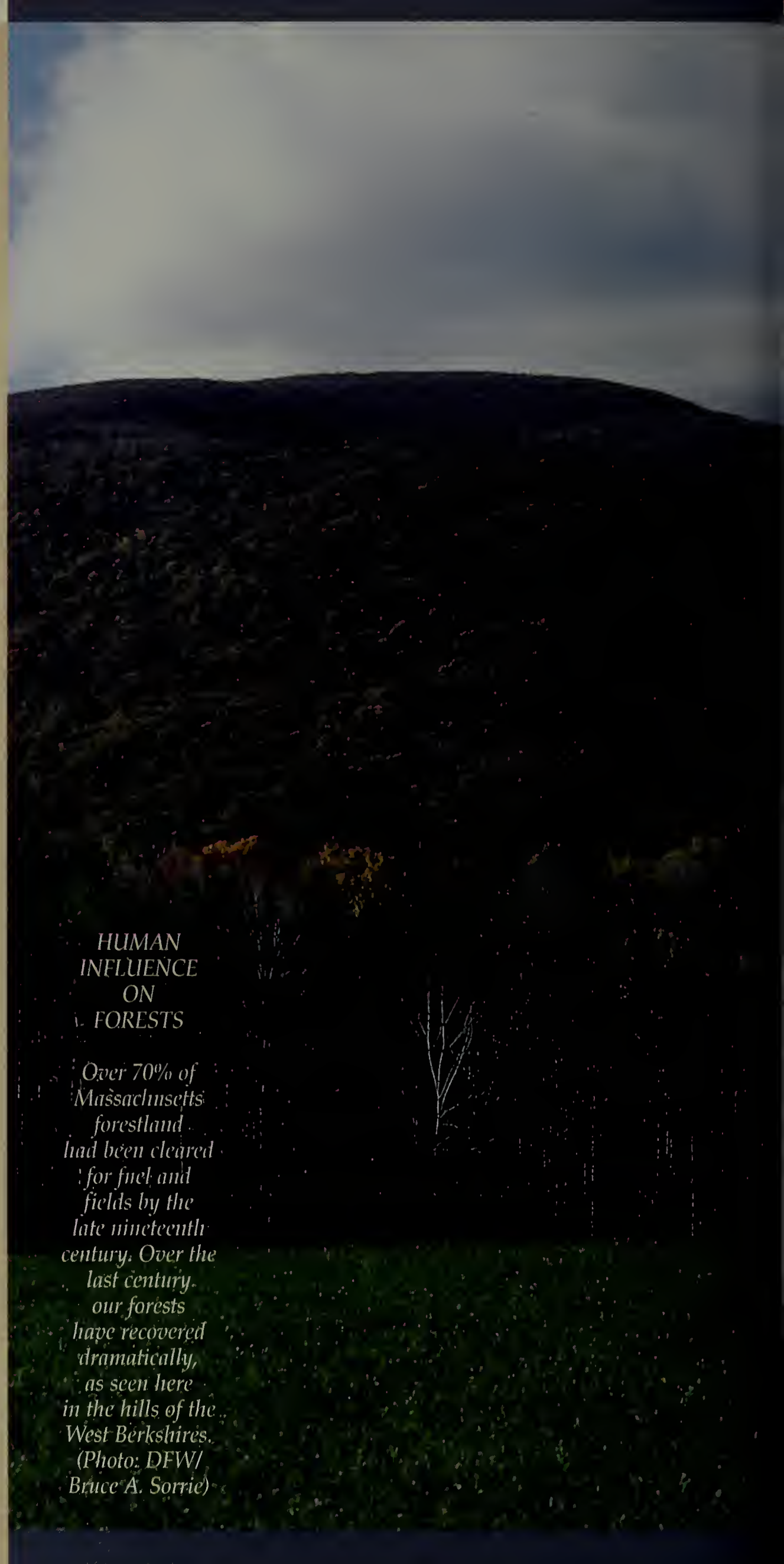
The glacial age, which gave Massachusetts its present face, began one million years ago. Five separate times the climate cooled and a great ice sheet, up to a mile thick, moved over New England from the north, grinding away trees, topsoil, and even the bedrock of hilltops. Each ice age was followed by a warmer period when the ice began to melt and eventually withdrew.

As each glacier melted it dropped its load of ground-up rocks, gravel, and sand at its southern edge. This process created the flat, sandy soils of southeastern Massachusetts. Nantucket and Martha's Vineyard mark the end of the next-to-last glacier. The most recent glacier, which withdrew only 12,000 years ago, left Cape Cod and the Elizabeth Islands as its legacy. The rich offshore fishing grounds of Stellwagen and Georges Banks are submerged remnants of the same glacial lands.

THE FORESTS RETURN

As the last glacier withdrew, the first natural community to return was the grasslands of the treeless tundra, resembling present-day Labrador. The northern hardwood forest of maple, beech, and birch did not return to Massachusetts until about 9,000 years ago. Today these hardwood forests are confined west of the Connecticut Valley, and to the northern Worcester Plateau. Ecologists define this area as part of the Northeastern Highlands ecoregion.

Within the Connecticut Valley, the southern Worcester Plateau, and the entire coastal zone (the area defined as the Northeastern Coastal Zone ecoregion), the warmer temperatures and longer growing season supported the eventual spread of more southern forest types. Most of the Coastal Zone ecoregion is dominated by a mixture of oaks and hickories, part of a hardwood forest that extends south along the Appalachians as far as Georgia. But on the sandy glacial soils of the southeast, Cape Cod, and the Islands we find a distinctive pitch pine–scrub oak forest, similar to that found on Long Island and in the New Jersey Pine Barrens.



HUMAN INFLUENCE ON FORESTS

Over 70% of Massachusetts forestland had been cleared for fuel and fields by the late nineteenth century. Over the last century, our forests have recovered dramatically, as seen here in the hills of the West Berkshires. (Photo: DFW/ Bruce A. Sorrie)

Shortly after the last of the glaciers left, the first settlers arrived in Massachusetts: Native American hunters, following herds of game northward. Stone spearheads dated as early as 8000 BC have been found in the Ipswich River valley. Subsistence patterns changed considerably over the years, as the climate warmed and the forests changed. The first European explorers and settlers along the Massachusetts coast encountered villages of Algonquin peoples, who spoke a common language but were organized politically in several loose tribal federations.

Native American populations were most dense along the coast and in the Connecticut Valley, where farmers grew corn, beans, squash, and tobacco. They supplemented their diets with seasonal fishing and hunting. The park-like forests that the early Europeans described, with tall trees and little underbrush, appear to have been the product of fires deliberately set by the Native Americans to make hunting easier.

MAP 1.1: ECOREGIONS OF MASSACHUSETTS

Northeastern Coastal Plain Ecoregion
• Warmer climate, longer growing seaason
• Oak -- Hickory forest
Northeastern Highlands Ecoregion
• Cooler climate, shorter growing season
• Northern hardwood (maple, birch, beech) forest
Cape Cod and Islands Subregions
• Sandy, glacial soils
• Scrub Oak -- Pitch Pine forest

Source: Adapted from US EPA

Climate and forest types define the state's major biological regions.

1

THE EXTRACTIVE ECONOMY: FARMING COMMUNITIES

By the mid-eighteenth century, the Massachusetts economy depended upon farming and the sea. This early economic history survives in the mosaic of small fields and woods, coastal villages, and town centers marked by a church steeple on the common.

With the arrival of English settlers in 1620, Massachusetts became a part of the global marketplace. Population migrations from Europe brought new crops, animals, and technologies that radically changed the environment. Smallpox, measles, and other European diseases killed most of the Native Americans; wars and one-sided treaty agreements restricted the survivors to small settlements on marginal lands.

Farming and fishing came to characterize the economy because other resources were scarce or quickly exhausted. Massachusetts is not rich in minerals, although "bog iron" accumulated in peat bogs did support America's first iron industry in Saugus. By the early 1700s the beaver had been eradicated in Massachusetts, forcing fur traders to push into neighboring colonies to the north and west. Similarly, once the great

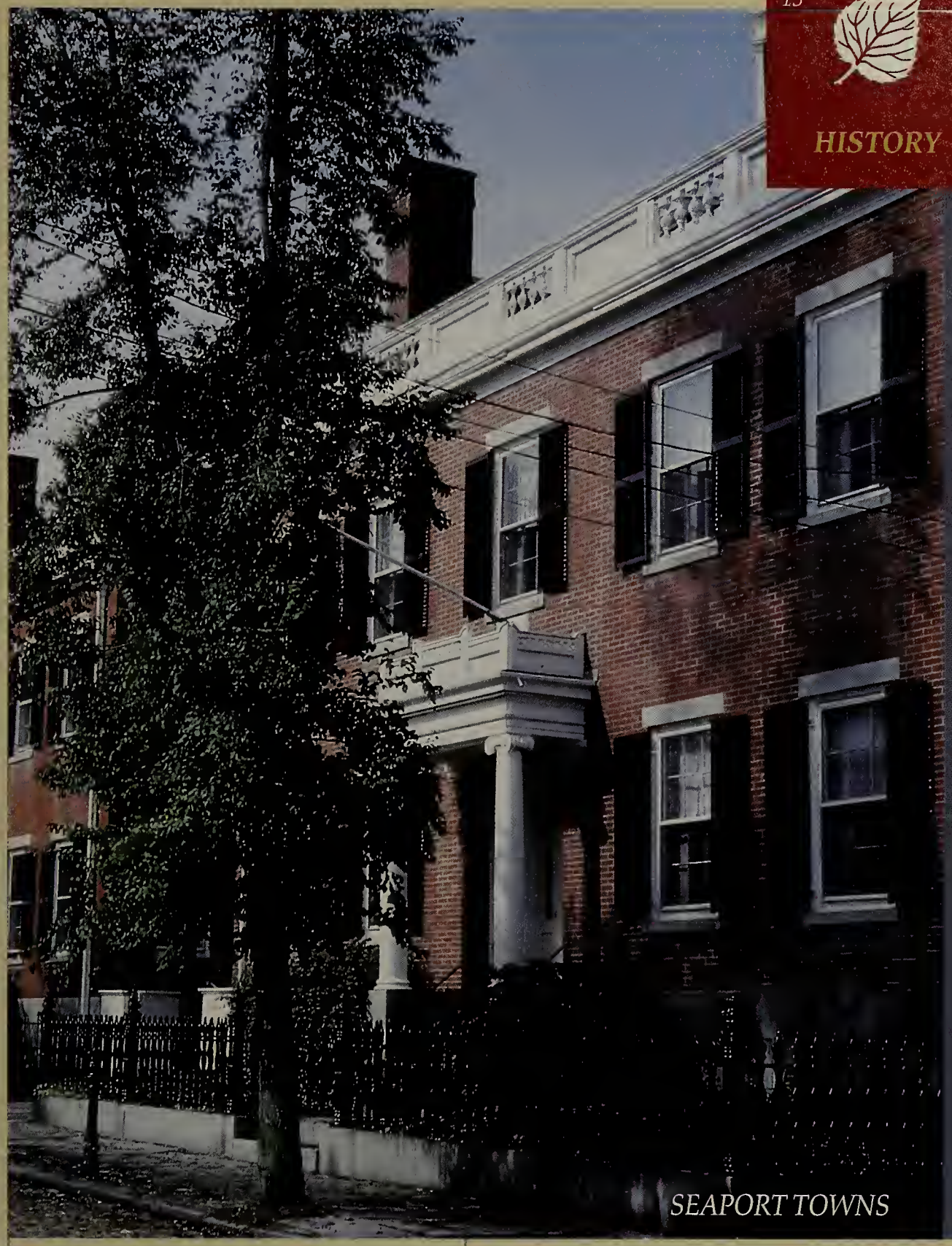
This town center in western Massachusetts typifies the small farming communities that had spread across the state by the early 1800s. (Photo: EOEA)

white pines that furnished masts for the ships of the British Navy had been cut, lumbermen turned their attention to the forests of New Hampshire and Maine.

Permanent European settlements began along the coast and then pushed inland following the river valleys. By 1820 the Massachusetts population had exceeded 500,000. Most people lived on farms or in small rural villages; only one in five lived in Boston, Salem, or other large towns. Farms were generally small, 100 to 200 acres in size, with about one-third of the land in crops, one-third in pasture for horses, cows, and sheep, and one-third as the woodlot for timber and fuel.

Farming communities spread all across the state. Of the 351 cities and towns in Massachusetts, all but three were founded before 1815. Most towns had a common, a public open space around which the meeting house and other major buildings were located.

Farming in Massachusetts reached its peak around 1850 and then began to decline as men and women moved away, drawn by richer soils in the Midwest or factory jobs in the cities. The stone walls that one finds throughout the woods shows how the forest has reclaimed old fields and pastures. Even today, the population of many towns in central and western Massachusetts remains below nineteenth-century levels.



SEAPORT TOWNS

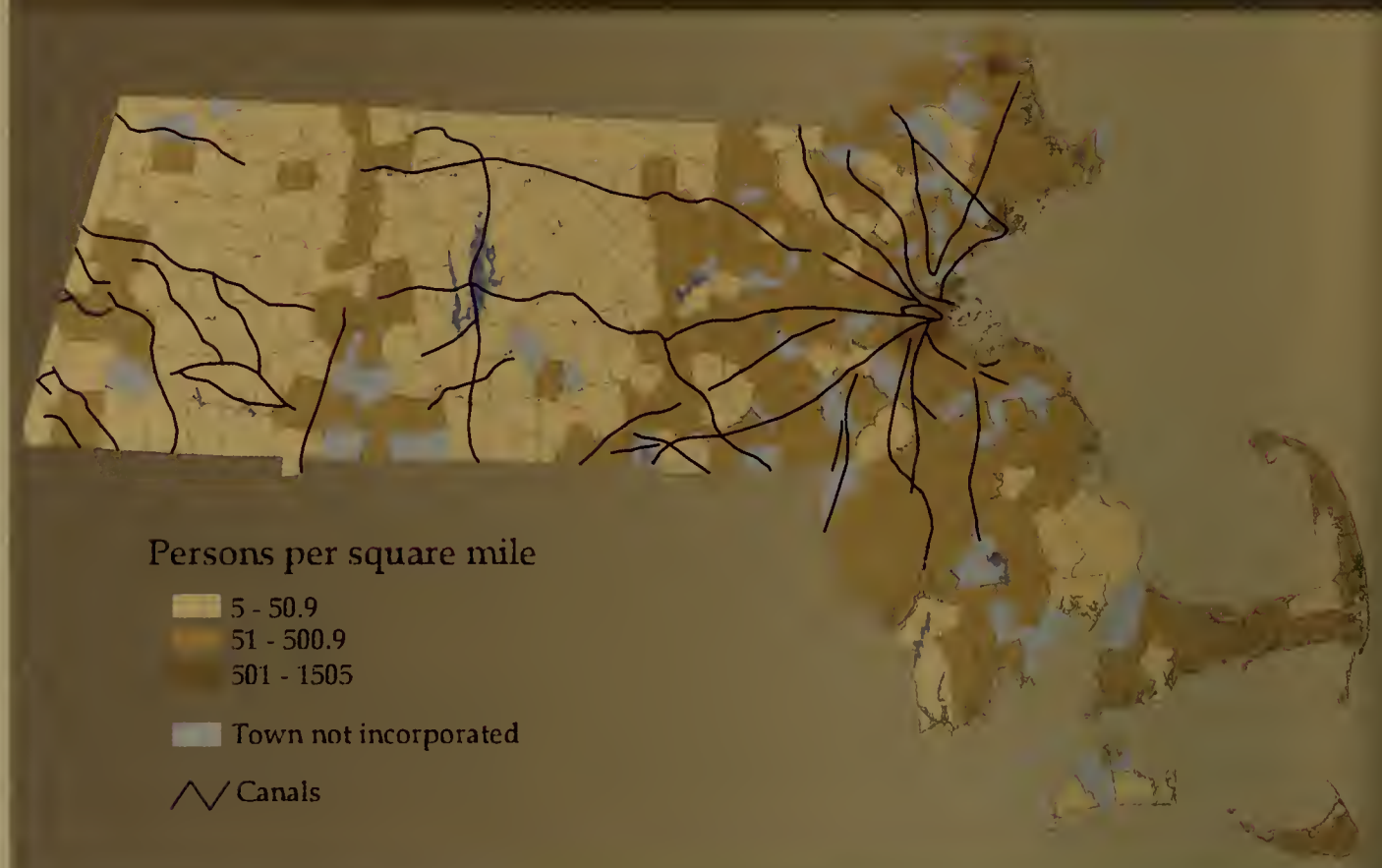
Along the coast, Boston, Salem, Marblehead, Newburyport, and other ports sent trading ships to the West Indies, Europe, and China. Nantucket whalers embarked on two-year-long voyages, often into the Pacific and around the world.

This Federal style captain's house in Nantucket, listed on the State Register of Historic Places, displays the riches produced by whaling. (Photo: EOEA)

Fishermen from North Shore towns had long relied on the rich schools of cod on Georges Bank, east of Cape Cod, and the more distant Grand Banks off Newfoundland. The money from shipping, whaling, and fishing was reinvested in new construction. By 1800, architects such as Boston's Charles Bulfinch and Salem's Samuel McIntyre were designing elegant houses and public buildings in the distinctively American Federal style of architecture.

Farming, fishing, and forestry remain important elements of the economy today, particularly in certain regions. Fishing and cranberry growing are both critical to the economic health of southeastern Massachusetts; dairy farming and forestry are still vital to many communities in western Massachusetts. Although farming accounts for approximately 1% of the state's jobs, it still occupies 12% of the total land area. 62% of the state is forested. Farmlands and forests provide many environmental benefits, from protecting clean water and rare species to preserving the quality of life.

MAP 1.2: POPULATION DENSITIES IN 1820



Source: Adapted from Wilkie & Tager, Historical Atlas of Massachusetts

In 1820 the state's population was 523,000, mostly on farms and in small towns. Only one-fifth lived in Boston and other large towns. Rivers and canals were the major transportation routes.

THE INDUSTRIAL ECONOMY: MILLS AND CITIES

America's Industrial Revolution began in Massachusetts and neighboring Rhode Island. In 1814 a group of wealthy Boston merchants formed the Boston Manufacturing Company to build a water-powered cotton mill on the Charles River in Waltham. Seven years later, the same group took advantage of the taller and more powerful falls on the Merrimack River to build the first mill in what would become the city of Lowell.

The mills transformed Massachusetts. The early water-driven mills were built along the rivers — often just down the hill from an existing farming community, which provided the labor. But as a network of railroads replaced travel by river, canal, and turnpike, starting in the 1830s, and as coal replaced water as the principal energy source, mills and factories became concentrated in a few major cities, including: textiles in Fall River, Lawrence, Lowell, and New Bedford; shoes in Brockton, Lynn, and Marlborough; and paper in Holyoke.

The creation of modern industrial infrastructure systems — water, sewers, power, and transportation — made possible the growth of big, dense industrial

ADAPTIVE REUSE OF HISTORIC MILLS

Many historic factories and mills are being reused for offices, research laboratories, and housing (as pictured here at the Eagle Mill in Uxbridge) – often with the help of historic preservation grants and tax credits. (Photo: EOEA / Bruner Cott Architects)

1.

cities. Streetcars and the nation's first subway, in Boston, linked new residential neighborhoods and suburbs to jobs and shops. Electricity provided a cheap, reliable source of light and power; the nation's first commercial electric plant opened in Great Barrington in 1886.

War; Italian, Eastern European, and French Canadian immigrants between 1860 and 1920. The 1920 census showed that over two-thirds of the state's population were first- or second-generation immigrants.

The rise of industry affected the countryside as well as the cities and

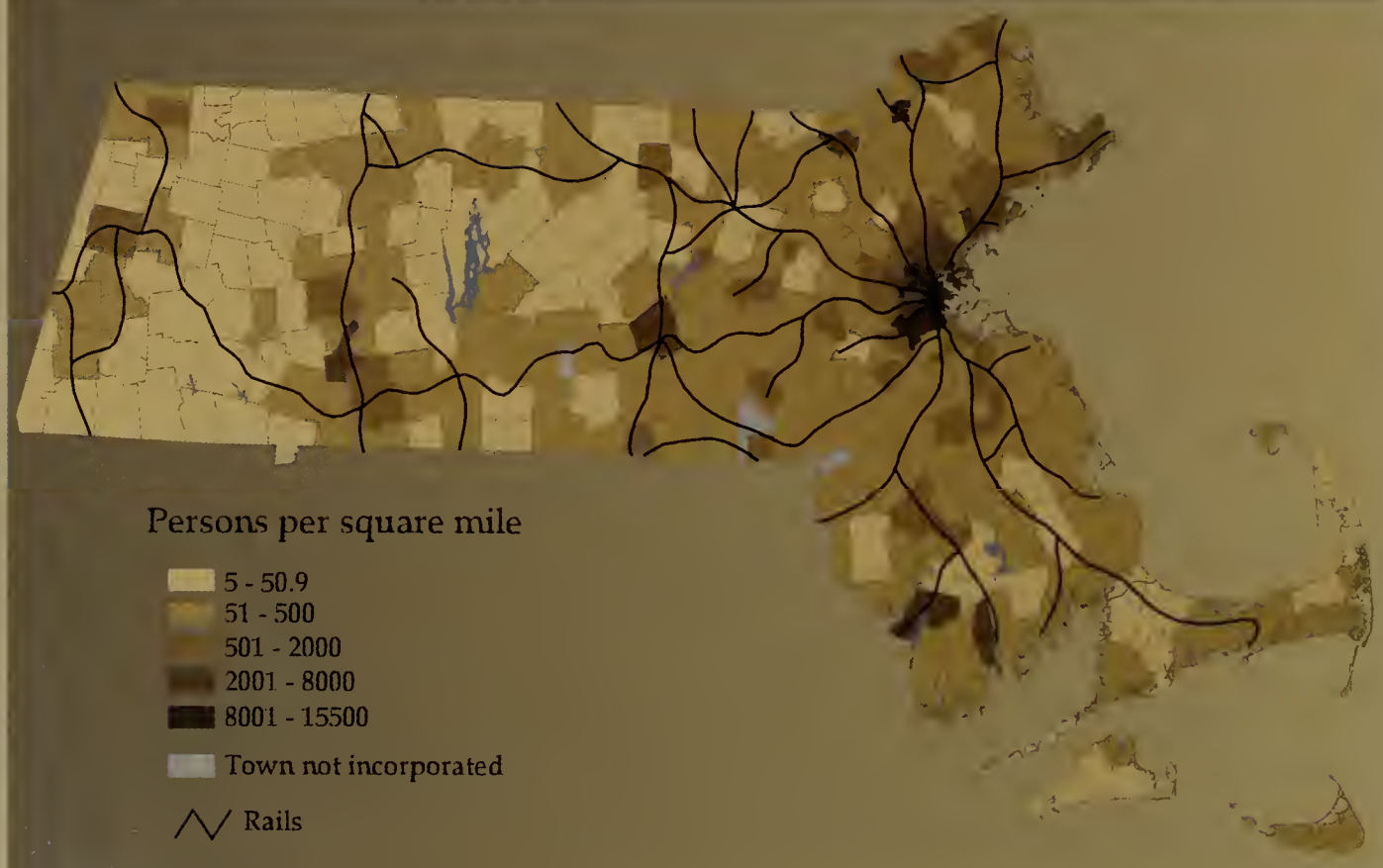
crates for products from the mills provided a new market for timbering. The deforestation of the Massachusetts landscape reached its peak around 1870, when only 30% of the state remained wooded.

Industrialization also spurred the growth of the fishing industry. Railroads could ship fresh fish to inland markets, reducing the demand for the traditional dried salt cod. In the 1920s, Gloucester's Clarence Birdseye pioneered the selling of frozen fish, and the market for Massachusetts fishing expanded yet again.

The industrial economy imposed a new set of stresses on the environment, which spurred the first environmental movement in American history. Factories and sewer systems discharged huge, concentrated flows of waste into rivers and harbors. Trash accumulated in local dumps. Coal-burning stoves and boilers created choking clouds of soot and smog.

In response, Boston and other communities formed Boards of Health that began to investigate the health hazards of these waste practices and then sought to solve the problems through regulations and new public systems. Municipal water and sewer systems provided clean, safe drink-

MAP 1.3: POPULATION DENSITIES IN 1900



Source: Adapted from Wilkie & Tager, Historical Atlas of Massachusetts

By 1900 the population had increased to 2.8 million, and by 1920 it had reached 3.8 million. Four-fifths of them lived in cities and large towns, linked by railroads.

Between 1820 and 1920, the population increased seven fold, from 523,000 to 3.8 million people. Over four-fifths of them were living in cities and large towns. Most of this explosive population growth came from immigration: Irish and German immigrants before the Civil

towns. The textile mills provided a new market for the wool from sheep farms, leading to much more widespread clearing of forests for pastureland. The early wood-burning railroads demanded still more timber for fuel. Later, wooden packing

ing water to city-dwellers, and began to deal with the problem of waste removal.

Attitudes toward nature began to change from exploitation to reverence. "In Wildness is the preservation of the World," wrote Concord resident Henry David Thoreau in his 1862 essay, *Walking*. By 1900, the destruction of treasured landmarks had spurred the creation of nonprofit groups, including the Trustees of Reservations and the Massachusetts Audubon Society, as well as government actions to preserve historic buildings and wilderness areas. Brookline resident Frederick Law Olmsted designed Boston's "Emerald Necklace," which still serves as a national and international model for a system of interconnected urban parks and parkways linking outlying neighborhoods to each other and to the central city.

Manufacturing reached its peak in Massachusetts around 1910, when it supported about 40% of the jobs in the state. It then began a long decline, as textile prices crashed and mills moved to the South. But today manufacturing still accounts for about 20% of the jobs in the state, and for 17% of the gross state product (GSP). Many of these jobs, especially in newer industries, are high-paying. The existing infrastructure of roads, railways, sewers, and large buildings with flexible open plans can be adapted to the needs of the new economy — as proven by the redevelopment of mill complexes in Lowell, Lawrence, and across the state.

PROTECTED PREDATOR.

One of the greatest challenges for early environmentalists was obtaining legal protection for birds of prey, such as the fish-eating osprey. (Photo: ©Kindra Clineff/ DEM)

THE INFORMATION ECONOMY

Over the past fifty years the state's economy has shifted again, led by four clusters of knowledge and skills: colleges and universities, computers and telecommunications, health care, and financial services. Many firms are headquartered in the new skyscrapers of Boston's financial district. (Photo: ©Kindra Clineff/DEM)

THE INFORMATION ECONOMY

Since the 1920s, the Massachusetts economy has been transformed yet again, with a new set of consequences for the environment. Manufacturing jobs have declined from 40% of the workforce around 1920 to less than 20% today. Farmland, which amounted to over 1 million acres in 1950, has dropped to 600,000 acres today. Fishing catches have fallen to only one-third the level of their 1947 peak.

During this decline, seeds of an economic recovery were planted. In the information age, brainpower is the key resource. Four "clusters" of related skills and businesses have enabled Massachusetts to foster technological innovation and economic growth: higher education (the Boston region possesses more universities and colleges than any other American city); computer and telecommunications businesses, which draw upon academic research; hospitals and health care; and the financial industry. Today, almost 50% of the state's jobs and GSP are in the service and the financial/ insurance/real estate sectors of economy.

Associated with the new economy was the creation of a new transportation infrastructure, based on the private automobile and the airplane. Between 1936, when construction of Route 128 began, and the early 1980s, when I-495 was completed, the state and federal governments constructed a statewide system of limited-access highways, with Boston as its hub. Logan Airport had expanded to its present size by the early 1970s, through the filling of large parts of Boston Harbor.

These highways were originally intended to bypass urban congestion, but road building soon spurred residential growth in outlying suburbs. Shopping and jobs soon followed. Shopper's World in Framingham was one of the nation's first shopping malls; Route 128 became the focus for industrial complexes, which are now being redeveloped as bigger, denser office parks.

The information economy is no longer dependent on dense cities for its workforce. Today, over half of all office space in the Boston metropolitan region is located outside of the core communities of Boston and Cambridge. As public and private investment shifted to the urban fringe, the historic cores of the cities were no longer valued. Large areas were torn down for highway construction, such as the existing Central Artery, or for urban renewal projects like Boston's Government Center and the West End.

The Massachusetts population has continued to grow, though more slowly than before, to its current level of about 6.1 million. Many immigrants have been drawn to older cities and towns, where housing is less expensive but jobs may be fewer. Despite the state's present prosperity, significant inequalities of income and access to public services persist, particularly in urban communities.

During the two decades following World War II there was a nearly unlimited faith in technological change and ever-expanding growth. But concerns grew over the side effects of technology, from pesticides to nuclear fallout. Environmentalists became increasingly aware of threats to human health, and to the carrying capacity of the natural ecosystems on which all life depends.

1970, the year of the first Earth Day, was a watershed. Congress passed the Clean Air Act and created the U.S. Environmental Protection Agency (EPA). Shortly afterwards, Massachusetts established the Executive Office of Environmental Affairs (EOEA), with a cabinet-level Secretary of the Environment, to oversee what have become the state's five environmental agencies: the Department of Environmental Protection (DEP), the Department of Environmental Management (DEM), the Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE), the Department of Food and Agriculture (DFA), and the Metropolitan District Commission (MDC).

At both the federal and the state level, there was a flood of new environmental laws passed in the 1970s — from the regulation of air pollution, water pollution, and solid and hazardous wastes, to the protection of wetlands, endangered species, parklands, and the coastal zone, to reviewing the environmental impacts of major projects. Transportation priorities changed, as Governor Sargent stopped construction of all new highways inside Route 128 in favor of new transit investments. The rehabilitation and redevelopment of Boston's Quincy Market, opened in 1976, showed that historic preservation projects could attract tourists and make money.

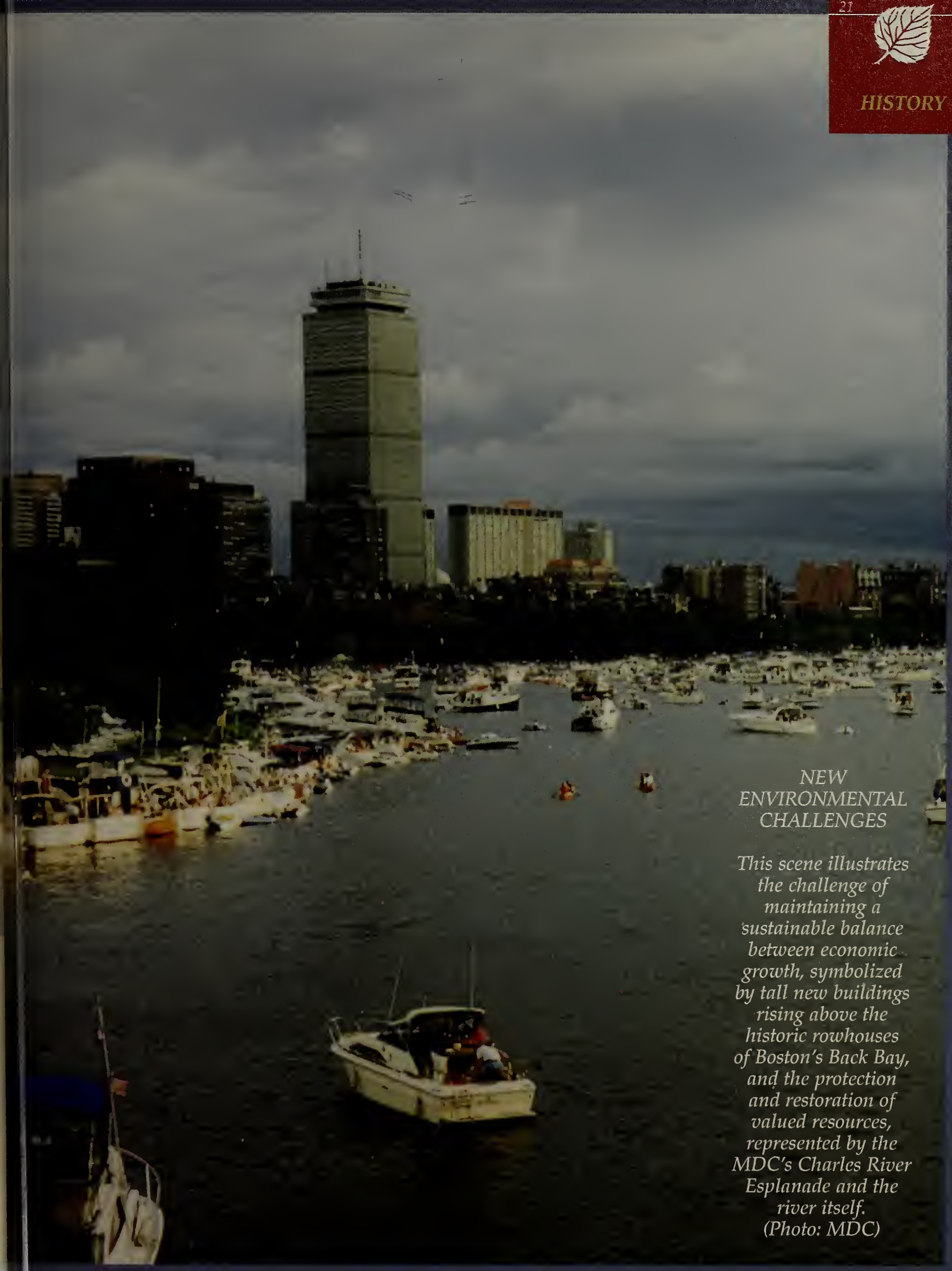
The expansion and strengthening of environmental protections have continued since the 1970s. New laws passed or implemented in Massachusetts over the last decade include the 1989 Toxics Use Reduction Act, the 1990 Endangered Species Act, the 1993 reform and privatization of Chapter 21E, the hazardous waste site cleanup law, the 1996 Rivers Protection Act, and the 1998 Brownfields Act.

Today, Massachusetts faces the challenge of protecting and restoring the environment, while allowing the economy to grow in a sustainable manner. Although direct industrial discharges have slowed with the shift away from an industrial economy, residents of older cities and towns continue to bear an unequal burden of environmental and public health risks caused by past and present releases. Meanwhile, "sprawl" patterns of land development are placing new stresses on water quality, wetlands, wildlife habitat, farmlands, and open space. Maintaining the quality of life in all communities is key to keeping and attracting jobs and residents to the state, and supporting tourism (which by some estimates may become the largest single sector of the state's economy by the year 2010). Massachusetts, having undergone the economic dislocations and environmental stresses of industrialization earlier than other parts of the country, can point the way to a healthier and more sustainable environmental future.

MAP 1.4: POPULATION DENSITIES TODAY

Source: MassGIS

Today the Massachusetts population is 6.1 million. Recent growth has been most dense along the major highway corridors.



NEW ENVIRONMENTAL CHALLENGES

This scene illustrates the challenge of maintaining a sustainable balance between economic growth, symbolized by tall new buildings rising above the historic rowhouses of Boston's Back Bay, and the protection and restoration of valued resources, represented by the MDC's Charles River Esplanade and the river itself. (Photo: MDC)

2.

COMMUNITY PRESERVATION

THE STATE

OF OUR

CITIES AND TOWNS

Each of the 351 cities and towns
that make up Massachusetts has a
unique history and physical character.
But "sprawl" patterns of development
are placing unprecedented strains on
our communities, our natural and
cultural resources, and our sense of
where we live and who we are.

Sprawl is the root cause of many
major environmental problems,
from the loss of wetlands and the
fragmentation of wildlife habitat,
to persistent water and air pollution,
to disinvestment in cities that threatens
historic resources and the health of
the most vulnerable members of our society.

The problem isn't development;
it's the wrong kind of development,
in the wrong places.
The best way to preserve open spaces
and valuable natural resources
is to redirect investment to the places
where it is most needed:
historic structures and neighborhoods,
contaminated brownfield sites,
and existing downtowns and town centers.
A healthy environment depends on cities
and towns that are physically attractive
and economically vibrant.
The goal of EOEA's Community Preservation
program is to involve citizens in shaping
the futures of their communities.

2.

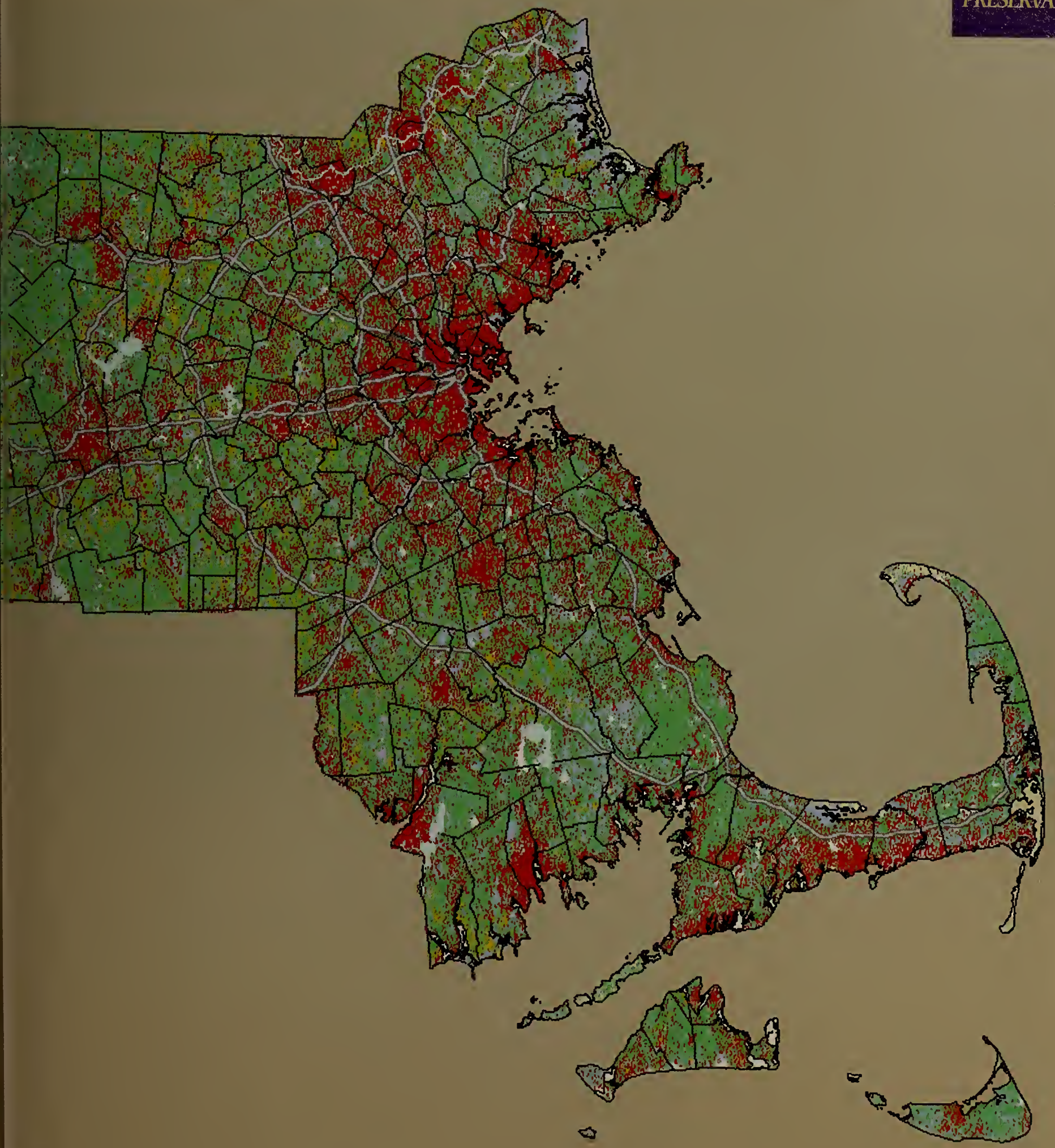
CITIES, TOWNS, AND SPRAWL

What is sprawl? Planners define it as low-density, single-use development on the urban fringe that is almost totally dependent on private automobiles for transportation. Sprawl is the landscape of the shopping mall, the office park, the residential subdivision. Since World War II, sprawl has become the dominant development pattern in Massachusetts, as in the rest of the country. All the different activities that were once concentrated in cities and towns are now spread thinly over miles and miles of land, connected by miles and miles of highway.

Since 1950, the population density of developed land in Massachusetts has decreased by more than 50%, from 11.19 persons/acre to 4.97 persons/acre. Each of us now consumes more than twice as much developed land as we did in 1950.

Sprawl is not a function of population growth. Between 1950 and 1990, the population of Massachusetts increased by only 28%. In that same period, the amount of developed land increased by 188%. We have used up more land in the half-century since 1950 than was developed in the three previous centuries.

MAP 2.1: LAND COVER PATTERNS



Source: MassGIS

62% of Massachusetts is currently forested, 12% is farmland, and 25% is developed.
We have developed more land since 1950 than was developed in the three previous centuries.

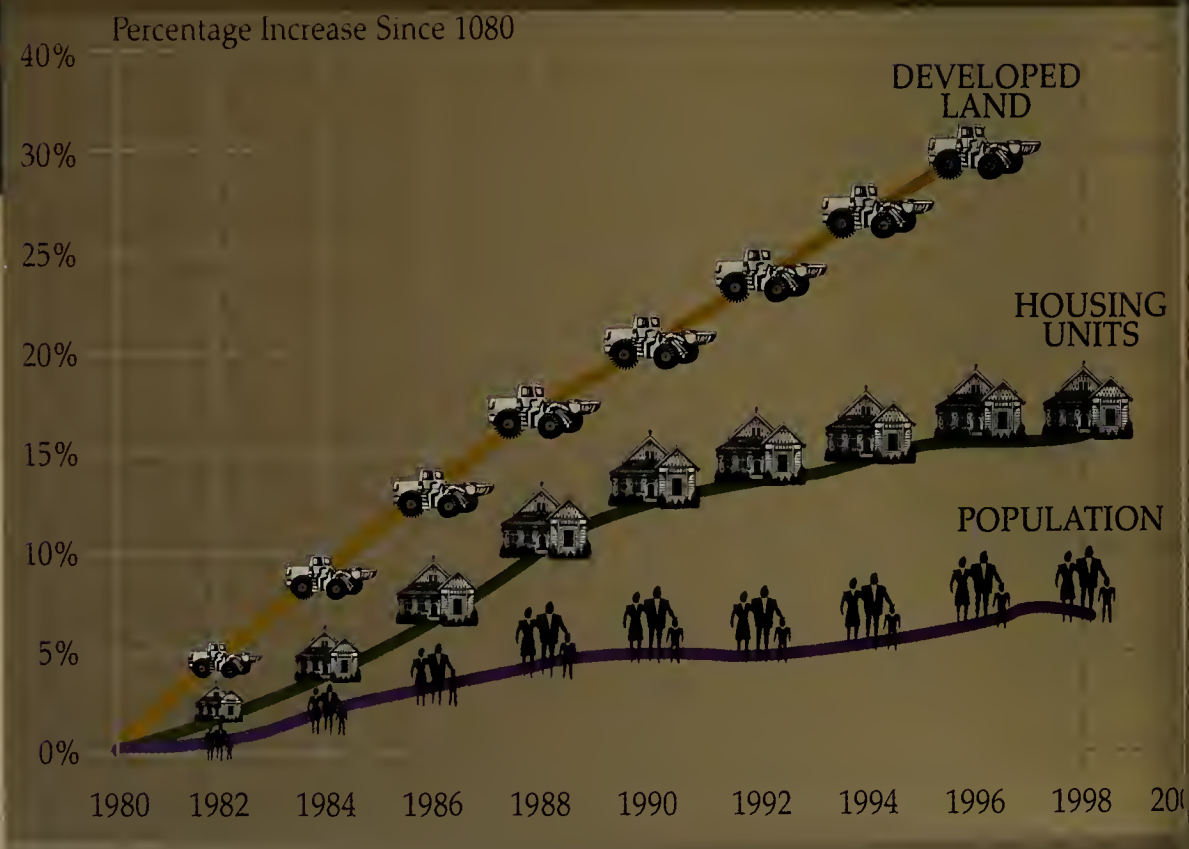
2.

ROADSIDE SPRAWL

Sprawl is defined as low-density, single use development on the urban fringe, almost entirely dependent on cars for transportation. (Photo: EOEA)

Although the overall population is not growing very quickly, there have been dramatic local gains and losses. Since 1950, the city of Boston has lost about one-quarter of its population, going from over 800,000 people to about 600,000 today. In the same period, suburban towns have increased in size several times over. Burlington has grown from 3,000 to 23,000, Framingham from 28,000 to 65,000, Plymouth from 14,000 to 46,000. This pattern holds throughout the state: older cities are losing population to their sprawling suburbs.

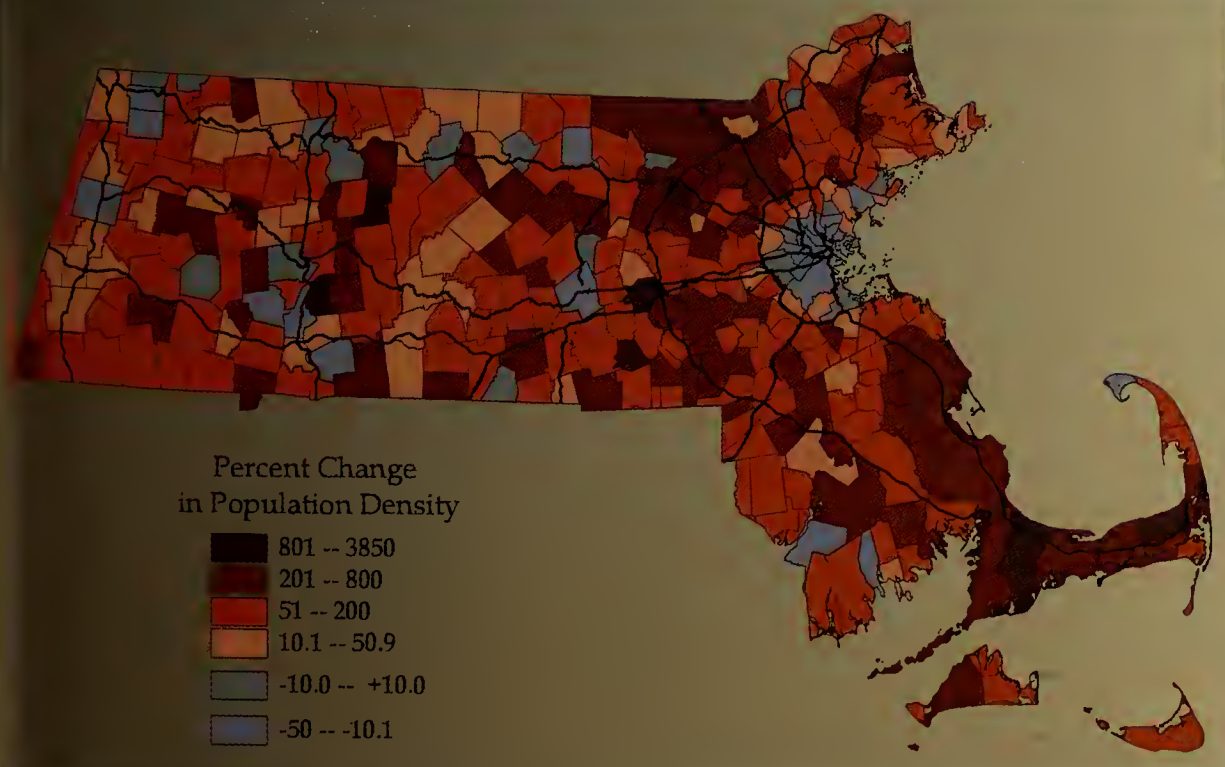
ENVIRONMENTAL INDICATOR 2.1: GROWTH TRENDS SINCE 1980



Source: Massachusetts Audubon Society, Losing Ground

Sprawl is not a function of population growth; we are developing land at a much faster rate than the population is increasing.

MAP 2.2: POPULATION GAINS AND LOSSES 1950 - 2000



Source: MassGIS

Although the population has grown slowly since 1950, there have been dramatic local changes. Older cities have lost population to their sprawling suburbs.

Sprawl is responsible for some of our most intractable environmental problems. Polluted stormwater runoff carrying oils, fertilizers, and other substances is the principal cause of degraded water quality in rivers, lakes, and coastal waters. (See Chapter 3.) Sprawl spreads these problems over larger and larger areas. In addition, the impervious surfaces of new roads, buildings, and parking lots prevent stormwater from percolating back into the ground and recharging our rivers, wetlands, and aquifers.

Sprawl also poses a threat to biodiversity. Although the landscape of sprawl may look green, fragmenting large areas of woods or fields into lots of little parcels and pieces has proved to be devastating to wildlife, endangering the future of up to 15% of our animal and plant species. (See Chapter 6.)

Sprawl has economic and social costs too. The most obvious of these is traffic congestion. On average, we spend 443 hours each year sitting in cars. Total hours of traffic delays in the Boston region nearly quadrupled between 1982 and 1997. Air pollution from cars and trucks is the single biggest source of smog, and of the greenhouse gases that are raising the earth's temperature. (See Chapter 5.)

In the land of sprawl there are no final answers to the problems of cars and traffic. Every time a road is built or widened to solve congestion problems, it encourages more driving, and the cycle of congestion starts all over again. Planners call this the Field of Dreams theorem: "If you build it, they will come."

Providing municipal services — new roads, new sewer and water lines, police and fire protection, schools and libraries — is much more costly when development is spread out. The added costs leave town governments struggling with difficult budget shortfalls.

As investment moves outward from our older cities and town centers, jobs, services, and housing are being lost from the places where they are most needed. The higher unemployment rates in older cities are partly due to the fact that too many new jobs are not accessible by public transit. Two-thirds of all trips to downtown Boston are by cheaper, less-polluting public transit, or on foot; in the rest of the state, that number drops to less than one in ten. Without new private investment in our cities, we lack the necessary funds to clean up contaminated brownfield sites and return them to productive use. Historic buildings are most at risk when no one is using them or caring for them.

Finally, sprawl affects our sense of place. William Whyte, one of the original experts on what makes a livable community, once observed that the first 5% of change in a landscape — the first new house or chain store in an open cornfield, the first demolition of a historic storefront for a parking lot on Main Street — is the most damaging. When people live farther apart and have to drive to get anywhere, there aren't any public spaces where they might run into each other. There aren't any town greens or town squares. Often there aren't even any sidewalks.

In other parts of the country, there is a strong push to design and build new towns that have main streets with shops and offices and apartments all mixed together, and residential neighborhoods within walking distance. This concept is called the "New Urbanism." But in Massachusetts, the New Urbanism is really the old urbanism. There is no need to build new towns that look like old ones here; Massachusetts already possesses three-centuries'-worth of cities and towns that are attractive, livable, and environmentally sound.

THE ENVIRONMENTAL COSTS OF SPRAWL

Though this subdivision may look green, its environmental costs include the destruction and fragmentation of wildlife habitat, and impacts on water quality and quantity caused by covering the ground with buildings, roads, and other impervious surfaces. (Photo: EOEA)

EOEA'S COMMUNITY PRESERVATION PROGRAM

The Community Preservation Program, sponsored by the Executive Office of Environmental Affairs (EOEA), is designed to empower citizens and local officials to guide how and where any development occurs. EOEA has now been joined in this effort by the Department of Housing and Community Development (DHCD) and the Department of Economic Development.

In an active effort to assist this process of community decision-making, the following will be offered to each community:

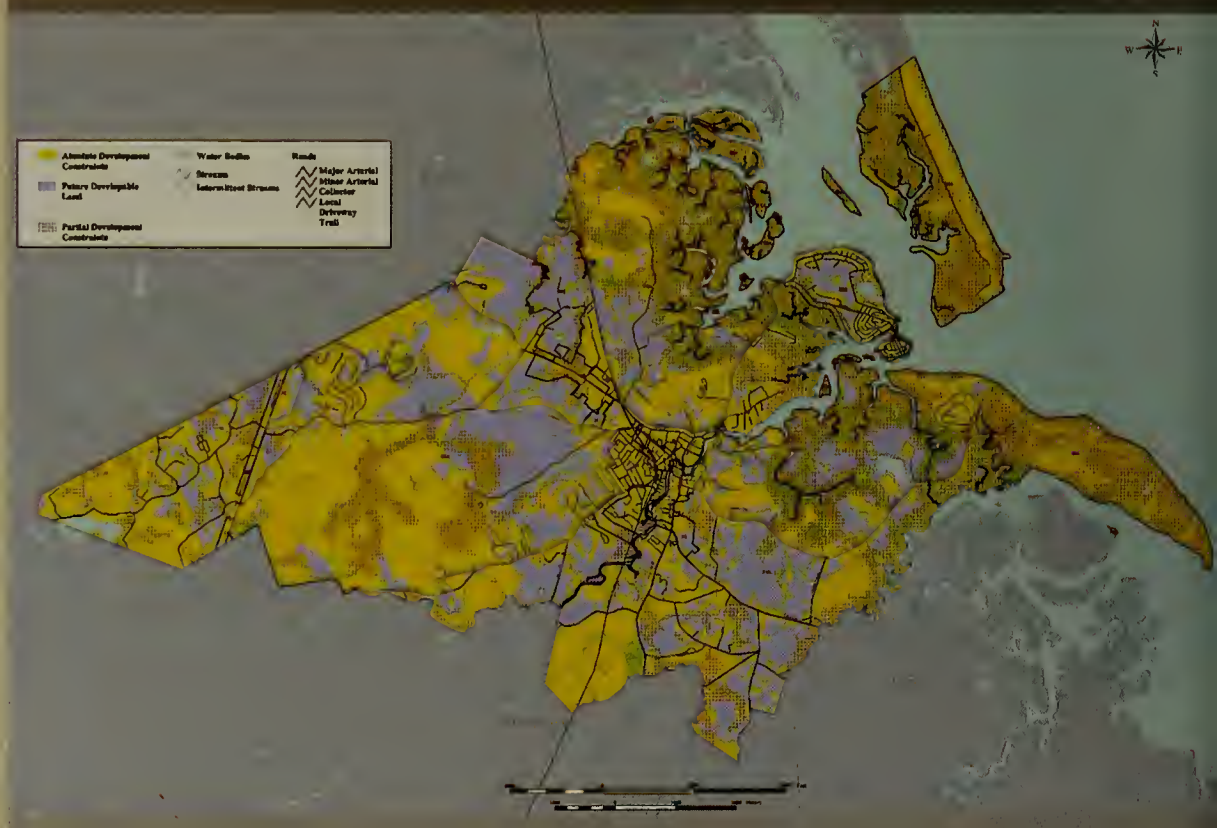
- A detailed buildout map and analysis of current conditions and the consequences of maximum potential future growth.
- Funding and technical assistance to develop a community plan.
- Funding and technical assistance to plan for sewers, water, and other public infrastructure.
- Advice on modifying local zoning and other land use regulations to support the goals of the plan.
- Funding for open space planning and preservation.

Buildout map and analysis.

Community planning begins with accurate and easily understood information on current conditions and future trends. EOEA, working with the state's thirteen regional planning agencies, will have completed a buildout map and analysis for every city and town in Massachusetts by June 2001.

Using the state's computerized Geographical Information System (GIS), each buildout map documents the maximum potential future growth allowable under current state regulations and local zoning. The accompanying analysis shows the consequences that maximum growth would entail in terms of population, housing units, school enrollments, gallons of water consumed and sewage generated, miles of roads, and other key indicators.

MAP 2.3: BUILDOUT MAP FOR IPSWICH



Source: Metropolitan Area Planning Commission (MAPC)

Community planning begins with accurate information. Each buildout map documents the potential for future development allowable under state regulations and local zoning.

DEVELOPMENT PRESSURES ON OPEN SPACE

Sprawl affects every region, particularly along major highway corridors. Development pressures are causing more and more farms to be converted into housing. (Photo: EOEA)

Community planning.

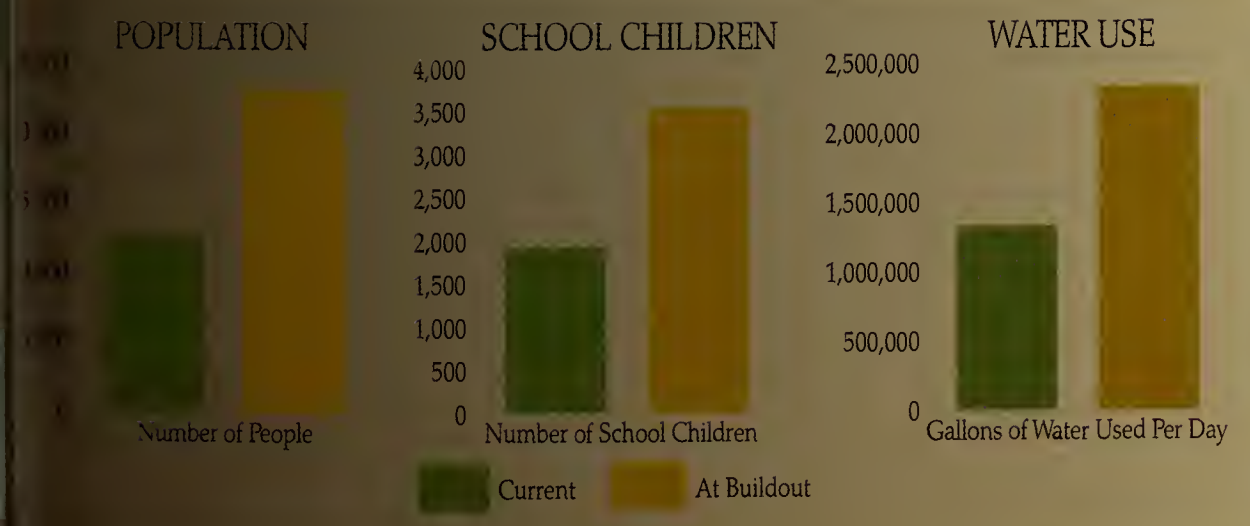
Planning for the future of a community is not simple; it involves understanding and balancing the needs of rich and poor, young and old. Planning may require hard choices about which resources need the most protection and where growth can occur most appropriately. A successful plan must be developed through an inclusive public process, and it must reflect a consensus vision of the community's future.

Good planning costs money. Although some cities and towns have a professional planning department, most communities lack the necessary resources. To rectify this problem, in January 2000 Governor Cellucci issued Executive Order 418, providing $9 million in new funds for community planning. Under the Executive Order, EOEA, DHCD, and the Executive Office of Transportation and Construction (EOTC) will jointly fund up to $30,000 to each city and town in Massachusetts for creation of a community development plan. Each plan will address proposed locations for affordable housing, locations for commercial and industrial development, planned infrastructure improvements, and the preservation of open space.

Public roads, water, and sewers.

The most important factor in determining where growth will occur is often the availability of public infrastructure services: roads, water, and sewers. Infrastructure investments should correspond to community planning goals. If a certain part of town has been identified as appropriate for open space preservation and low-density development, it doesn't make sense to spend public money cutting down trees and removing stone walls to straighten a picturesque country road, or extending sewers through woodlands or working farms. Infrastructure investments should be targeted for the areas where they will do the most good: providing services to existing downtowns and neighborhoods, and enhancing the development potential of contaminated "brownfield" sites and other degraded areas.

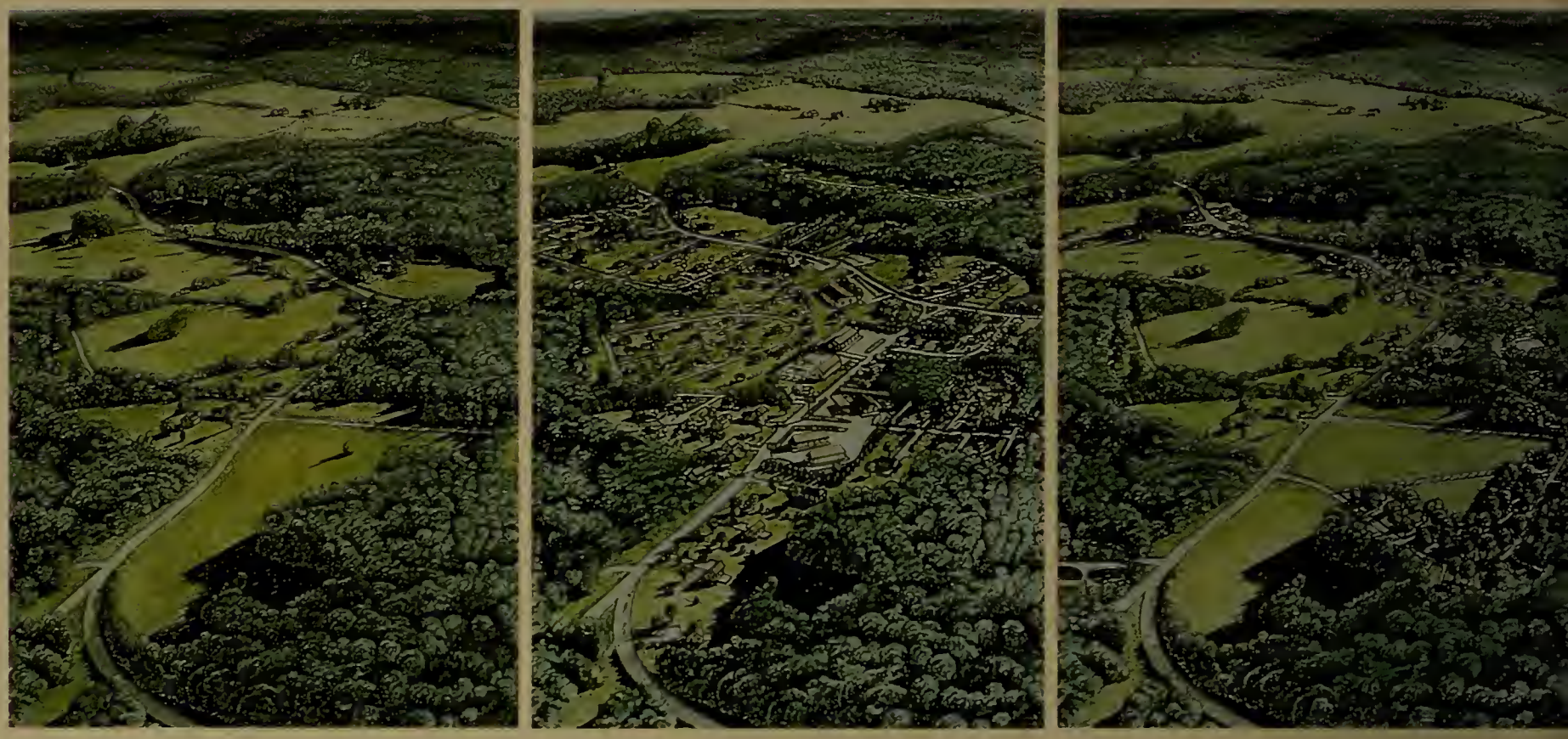
NVIRONMENTAL INDICATOR 2.2: UILDOUT ANALYSIS FOR IPSWICH



Source: MAPC

Analysis by EOEA and the regional planning agencies shows that most current zoning codes allow far more development than the community would want or absorb.

2.



DEVELOPMENT THAT SERVES OPEN SPACE GOALS

The left-hand panel shows a landscape of farmlands and forests. The middle panel shows unplanned sprawl development; the right-hand panel shows the same level of development, reconfigured through sensitive open space preservation practices. (Source: Randall Arendt and Harry Dodson, Dealing with Change in the Connecticut River Valley, ©Center for Rural Massachusetts)

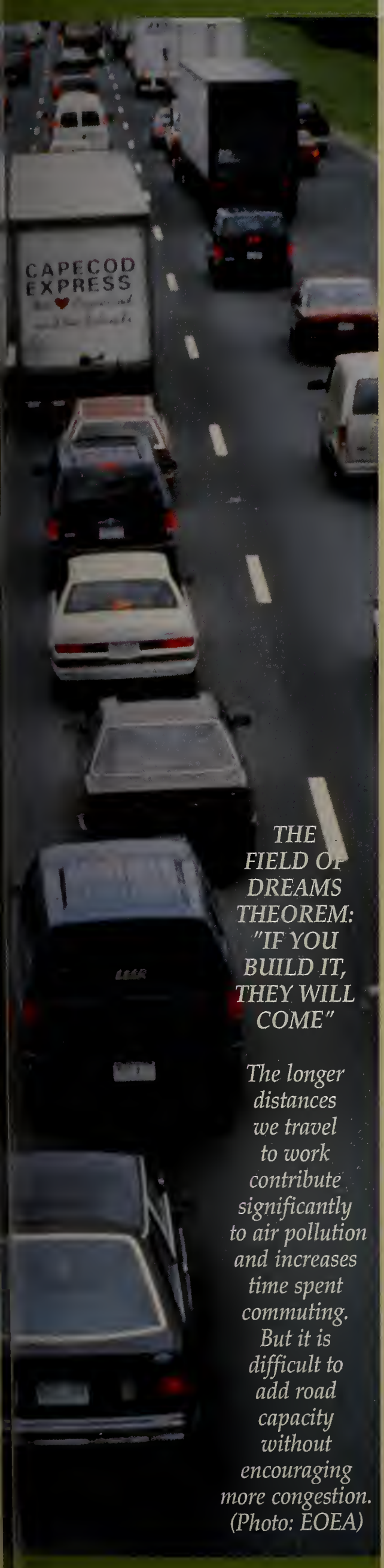
Zoning.

Under Massachusetts law, land uses are regulated primarily by local zoning codes. For this reason, another key element of implementation is ensuring that local zoning reflects the goals of the plan. The buildout analyses have shown consistently that most current zoning codes allow far more development than the community could possibly want or absorb, and that growth would often occur in inappropriate places. At the same time, zoning often makes it impossible to reproduce the liveable, pedestrian-friendly mixtures of shops, offices, and housing that we appreciate in historic town centers.

In addition to mapping out appropriate areas for growth and conservation, a zoning code should allow flexibility for well-designed projects. For example, "open space" or "cluster" designs preserve larger unbroken open spaces, while locating houses to maximize views and enjoyment of common areas. Zoning should also favor mixed-use developments that mingle housing, shops, and jobs and allow more people to walk instead of drive. Through a system of "transferable development rights" (TDRs), landowners in areas targeted for conservation can transfer development rights to areas targeted for growth.

Funding for open space, historic preservation, and affordable housing.

The proposed Community Preservation Act would provide a major new source of local funding to underwrite the goals of local planning. If adopted locally by the 351 cities and towns in Massachusetts, it is estimated that more than $200 million could be raised annually for communities to protect their open space, preserve their historic resources, and provide affordable housing opportunities for local residents. The Act would provide communities with flexibility in allocating the funds among these three areas.



THE FIELD OF DREAMS THEOREM: "IF YOU BUILD IT, THEY WILL COME"

The longer distances we travel to work contribute significantly to air pollution and increases time spent commuting. But it is difficult to add road capacity without encouraging more congestion. (Photo: EOEA)

ADDRESSING REGIONAL AND STATEWIDE DEVELOPMENT IMPACTS

Some projects have impacts that cannot be fully addressed at the local level. These include major regional transportation projects, other state facilities that are not subject to local zoning, and large private projects whose impacts spill over local boundaries or affect environmental resources of regional or statewide importance.

Addressing the regional impacts of growth requires regional plans that set priorities and goals for balancing preservation and development, as well as a process for reviewing major projects. The thirteen regional planning agencies in Massachusetts develop and update regional policy plans on an ongoing basis.

Special legislation for the Martha's Vineyard and Cape Cod Commissions provides for the regional permitting of Developments of Regional Impact (DRIs). The Massachusetts Environmental Policy Act (MEPA) Office within EOEA oversees public review of the environmental impacts of all major development projects undertaken by a state agency or involving state funding, permits, or land.

Executive Order 385, issued by Governor Weld in 1996, requires all state agencies to promote, assist, and pursue the rehabilitation and revitalization of infrastructure, structures, sites, and areas previously developed and still suitable for economic use or reuse. State agencies must favor such rehabilitation and revitalization, where practicable, over new construction or development in environmentally sensitive areas. Under Executive Order 385, MEPA review of individual projects must consider local and regional growth management plans.

REDEVELOPING BROWNFIELDS

Across Massachusetts, the decline in industrial activity has left many old factories and other sites abandoned or underused, blighting communities and posing risks to public health. Many of these "brownfield" sites are well served by existing water, sewer, and transportation infrastructure, and they are located near potential workforces. But such properties often lie dormant because they are tainted by oil or hazardous materials. Without new private investment, cleanups proceed slowly, and jobs and tax revenues are lost from the communities that most need them.

Returning brownfield sites to environmental health by fostering new investment and productive economic use is a key part of community preservation. In 1998 Governor Cellucci and the legislature worked together to enact one of the most innovative and comprehensive pieces of brownfields legislation in the nation. The Massachusetts Brownfields Act provides market incentives to attract developers back to abandoned and underused sites, while maintaining environmental standards. The Act favors projects that provide jobs and other tangible benefits and are located within the state's most economically distressed communities.

RECLAIMING BROWNFIELDS

Private and public investment in existing brownfield sites is restoring these areas to productive use. Projects such as the Worcester Medical Center, shown here, clean up environmentally degraded sites and contribute to the local economy. (Photo: VHB/ Vanasse Hangen Brustlin, Inc.)

As described in Chapter 4, the combination of legal uncertainty and the stigma of contamination associated with hazardous waste cleanups has caused developers, tenants, and lenders to avoid contaminated industrial sites in cities and town centers in favor of sites on open spaces and farmlands in suburban and rural areas. To address this problem, the Brownfields Act modified legal liability rules to encourage the involvement of private lenders and developers and public redevelopment agencies.

The Act provides $57 million in new state funding. On the principle that "the polluter pays," $30 million in loans is available only to innocent parties who are not responsible for contamination. The Act also makes available $15 million for state-subsidized environmental insurance, $10 million for increased DEP review of cleanups, and $2 million to support the Attorney General's Covenant-not-to-sue Program, through which property owners who complete cleanups are protected against future legal liability. Finally, the Act offers an investment tax credit of 25% to 50% for brownfields investments. The newly created Governor's Office for Brownfields Revitalization will lead the implementation of these new programs.

2.

KEEPING HISTORIC STRUCTURES AND LANDSCAPES ALIVE

Historic structures and landscapes are a vital part of our environment. Historic resources keep alive our sense of place and our connection to the past. They enhance the scenic qualities of our landscapes, they establish community character, and they help define what is unique about Massachusetts. And, like endangered species and natural communities, historic resources are irreplaceable. Once a building or a site is destroyed, it is gone forever.

Thousands of years of human history have left Massachusetts rich in historic resources. We have over 60,000 separate listings on the National Register of Historic Places — more than any other state. Historic resources range from Native American campgrounds to factories in Lowell and Holyoke, from shipowners' mansions in Salem to farmsteads in the Berkshires.

Massachusetts pioneered the way in preserving historic structures and districts. In 1876, the preservation of Boston's Old South Meeting House set a precedent for historic sites nationwide. Similarly, in 1955 Nantucket Center and Boston's Beacon Hill became two of the first historic districts to be protected by law.

Historic preservation is a vital part of the environmental agenda. The older cities and towns of Massachusetts offer handsome buildings with wood or stone details and streets and sidewalks scaled for pedestrians. By preserving and revitalizing these areas, previously developed land is used again, reducing development pressures on valuable open space. The adaptive reuse of historic buildings is another form of recycling, which avoids unnecessary waste of natural and energy resources.

PRESERVING THE FABRIC OF DOWNTOWNS AND TOWN CENTERS

Massachusetts downtowns and town centers offer attractive buildings and streets scaled for pedestrians. Focusing investment in these areas saves historic buildings from neglect and decay and preserves open space. (Photo: EOEA)

BRINGING NEW LIFE TO OLD BUILDINGS

This $3.7 million project converted the Chelsea Post Office into a satellite campus for Bunker Hill Community College. (Photo: Tom Lingner / Vanderwarker Studios / Finegold Alexander Architects)

Historic preservation also makes good economic sense. Compared with new construction, the rehabilitation of old buildings creates more construction jobs because it is more labor intensive. The unusual, less expensive space in older buildings can provide invaluable incubator space for new start-up companies. Communities as diverse as Northampton, Nantucket, and Lowell have shown that restored historic districts can draw tourists and revitalize the local economy. Finally, preserving the physical fabric of downtowns and neighborhoods helps reinforce a sense of community pride.

Both state and municipal agencies can help local preservation efforts. The Massachusetts Historical Commission coordinates the ongoing cataloguing of historic resources, and it provides funding and technical assistance for preservation projects. The Commission also reviews all projects involving state or federal agencies, permits, or funds to ensure that there are no adverse impacts on historic resources.

There are also over 400 local historical commissions, in almost every city and town, and over 100 local historic district commissions that review new construction and protect buildings and sites from needless destruction. Although landowners sometimes fear that designation will affect property values, studies all across the nation have shown that in the long term it stabilizes and enhances the investment value of historic resources.

Despite these successes, the struggle to protect our historic heritage is ongoing. Historic sites and landscapes in rural areas are under threat from sprawl. Meanwhile, the lack of investment in cities places historic sites at risk there too. The greatest risk to old buildings is neglect and abandonment. Through DEM's Historic Curatorship program, the state is offering historic state-owned properties at below-market leases, so that such buildings are actively used and cared for.

THE VALUE OF FARMLANDS

Despite earlier declines, farmlands still account for 12% of the state's total area. Farms, like this one in Leominster, support local and regional economies, and provide significant environmental benefits for water supplies, wildlife habitat, and open space. (Photo: EOEA)

PRESERVING OUR FARMLANDS

Agriculture remains a significant part of the Massachusetts economy. About 12% of the state's total area is still devoted to farming — a percentage that is much higher in certain areas, notably the Connecticut and Housatonic Valleys and southeastern Massachusetts. The continued preservation of farmlands has important environmental benefits, from the protection of watersheds and wildlife habitat (many grasslands species are now rare because of the decline of open fields) to the preservation of historic landscapes.

Most of the farms that shaped our landscape in the nineteenth century are gone. As recently as 1945 there were more than 37,000 farms in the state, compared with the 1974 low of 4,497. In recent years, however, the loss of farmland has stabilized, and the total number of farms has actually increased to 6,200, covering 570,000 acres of land. Four out of five Massachusetts farms are family-owned.

Although most Massachusetts farms are small, they are very productive. Nationally the state is second in cranberry production, ninth in maple syrup, and twelfth in sweet corn. In 1998 Massachusetts farms generated a total of $459 million in cash receipts. Secondary purchases of feed, seed, fertilizers, and other supplies accounted for another $212 million. Beyond this, the food processing industry generates $2 billion dollars and employs nearly 19,000 workers.

Farming is not easy in the best of conditions, but Massachusetts conditions are particularly challenging. Neighbors who may have bought their homes because they liked the look of a rural setting may not appreciate the smells and sounds of a working farm. The development value of land may far exceed its worth for continued farming. Supermarkets can buy cheaper produce from countries where laborers earn just pennies an hour.

In response to these pressures, farmers are adapting to changing market conditions so they can remain viable businesses. Many farms have shifted from traditional wholesale growing into selling directly to consumers. Massachusetts farmers are second nationally in value of average direct market sales, at $16,000 per farm. Many farms offer activities to visitors, from farm tours, harvest festivals, and cut-your-own Christmas trees to bed and breakfast accommodations, hiking, and cross-country skiing. These tourist attractions pump money into the local economy.

Massachusetts farmers are also making greater use of the environmentally sensitive Integrated Pest Management (IPM) approach to pest control. IPM relies on biological, cultural and mechanical methods to reduce reliance on chemical pesticides. Research and demonstration projects sponsored by the Department of Food and Agriculture and the University of Massachusetts show that IPM reduces pesticide use from 25% to 70%, depending on the crop, without sacrificing crop yields or quality.

EOEA is committed to providing farmers with the help and support they need. The Department of Food and Agriculture currently protects from development over 44,000 acres in 132 different communities under its innovative Agricultural Preservation Restrictions (APR) program. The Farm Viability program protects over 8,000 additional acres, through ten-year covenants-not-to-develop. EOEA will soon launch a targeted program for cranberry growers in southeastern Massachusetts, who are subject to particularly strong development pressures.

Local governments must review what they can do to protect farmland from further development and sprawl, by revising zoning regulations and focusing sewer and road investments in downtowns and previously developed areas. Local safety and health requirements that unduly raise the cost of doing business for farmers can also be revised without harming the public interest.

HARVESTING CRANBERRIES IN SOUTHEASTERN MASSACHUSETTS

Massachusetts is the nation's second largest cranberry producer, but competition from other states and falling prices heighten pressures to convert agricultural lands to other uses. (Photo: ©Frank Tedesco/DFA)

WHAT SHOULD BE DONE

By State Government

- Prepare and distribute a buildout map and analysis for each community to promote informed local decision-making.
- Continue to hold Preservation Summits to discuss buildout analyses and regional implications of growth.
- Implement Executive Order 418 by assisting communities in preparing Community Development Plans.
- Through MEPA review and DEP funding and permitting, ensure that new water, wastewater, and transportation investments are consistent with local and regional plans for growth and open space preservation, pursuant to Executive Order 385.
- Encourage streamlined MEPA review and DEP permitting of projects in brownfields, downtowns, and other appropriate growth areas, when consistent with local and regional plans.
- Provide funding and technical assistance for brownfields projects.
- Locate new state facilities in existing historic buildings or infill sites in downtowns and town centers.
- Start up the Massachusetts Heritage Landscape Inventory in southeastern Massachusetts to provide a model for statewide efforts.
- Provide technical and financial assistance to farmers, including DFA's Farm Viability and APR programs.

By Local Governments

- Develop Community Development Plans.
- Concentrate public infrastructure investments (roads, transit, water, and sewers) to serve existing developed centers and brownfields and avoid opening up new areas for development.
- Reform local zoning to encourage appropriate development patterns.
- Restore historic structures, landscapes, cemeteries, and town commons to productive use, with the help of MHC and DEM grants.

By Business

- Design and develop projects that protect open space and are within the capacity of existing infrastructure systems.
- Take advantage of legal and financial incentives to invest in brownfields and historic properties

By Citizens

- Support local and regional planning and land use efforts that discourage sprawl and conserve open space.
- Buy Massachusetts-grown products at the supermarket or local farmer's markets.

COMMUNITY PRESERVATION

3.

MANAGING WATERSHEDS

THE STATE OF OUR

RIVERS, LAKES, WETLANDS,

AND GROUNDWATER

Water is necessary for life,
yet human activities
can harm watersheds and their
natural water cycle
in many different ways.
Pollutants are discharged into rivers and
harbors, wash off the ground, or fall
with rain and snow from the air.
The filling of wetlands,
the damming of rivers,
and the paving of the ground
with roads and other impervious surfaces,
affect both the quality of the water —
whether it is fit to drink, swim in,
or fish in — and whether there is
enough water to go around.

To deal with these interrelated problems,
EOEA's Watershed Initiative treats each
of the state's 28 separate watersheds
as a single, self-sustaining unit.
The watershed program brings together
citizens and environmental agencies
to plan for the future of each watershed.

The past thirty years have seen
considerable progress in cleaning up discharges
from municipal sewage plants, factories,
and other "end-of-the-pipe" point sources.
Now efforts must focus on:
controlling nonpoint source pollution
from contaminated stormwater runoff;
restoring degraded wetlands and rivers;
and
balancing the water budget of each watershed,
keeping water local
to recharge rivers, lakes, and aquifers.

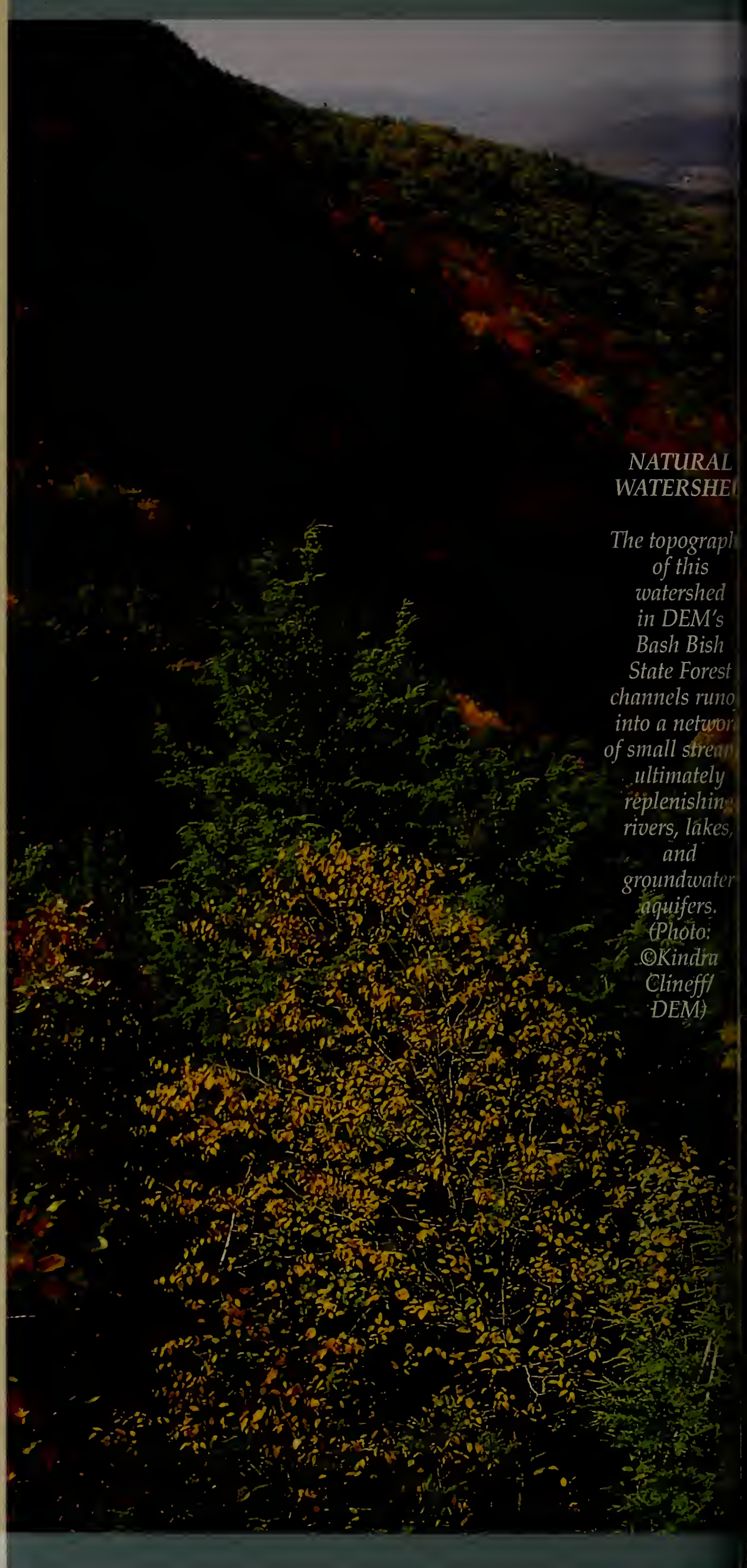
3.

OUR WATER RESOURCES

EOEA's Watershed Initiative starts by recognizing that all water resources – rivers and streams, lakes and ponds, wetlands, coastal estuaries, and groundwater aquifers – are inter-related.

Compared with most of the United States, Massachusetts is a water-rich state. Forty-five inches of precipitation fall in an average year, spread evenly throughout the four seasons. In wooded areas, half of the rainfall is taken up by the trees and plants, to evaporate back up into the clouds. The other half either runs over the surface to collect in rivers and lakes, or it sinks through the soil into underground reservoirs of groundwater.

When water hits the ground, the underlying shape of the landscape directs its future. The hills organize the land into watersheds, large areas in which runoff and streams feed a river, lake, or ocean. Massachusetts has 28 distinct watersheds (including the coastal waters), which feed six larger river basins. All the land between the peaks of the Berkshires and the Worcester Plateau — nearly one-third of the entire state — is drained by the Connecticut River and its tributaries. Most of the land west of the Berkshires drains to the Housatonic River. East of the Worcester Plateau, the watersheds feed the Merrimack, the Charles, and many smaller rivers that ultimately make their way to the coast.



NATURAL WATERSHE

The topograph of this watershed in DEM's Bash Bish State Forest channels runo into a networ of small strea ultimately replenishin rivers, lakes, and groundwater aquifers. (Photo: ©Kindra Clineff/ DEM)

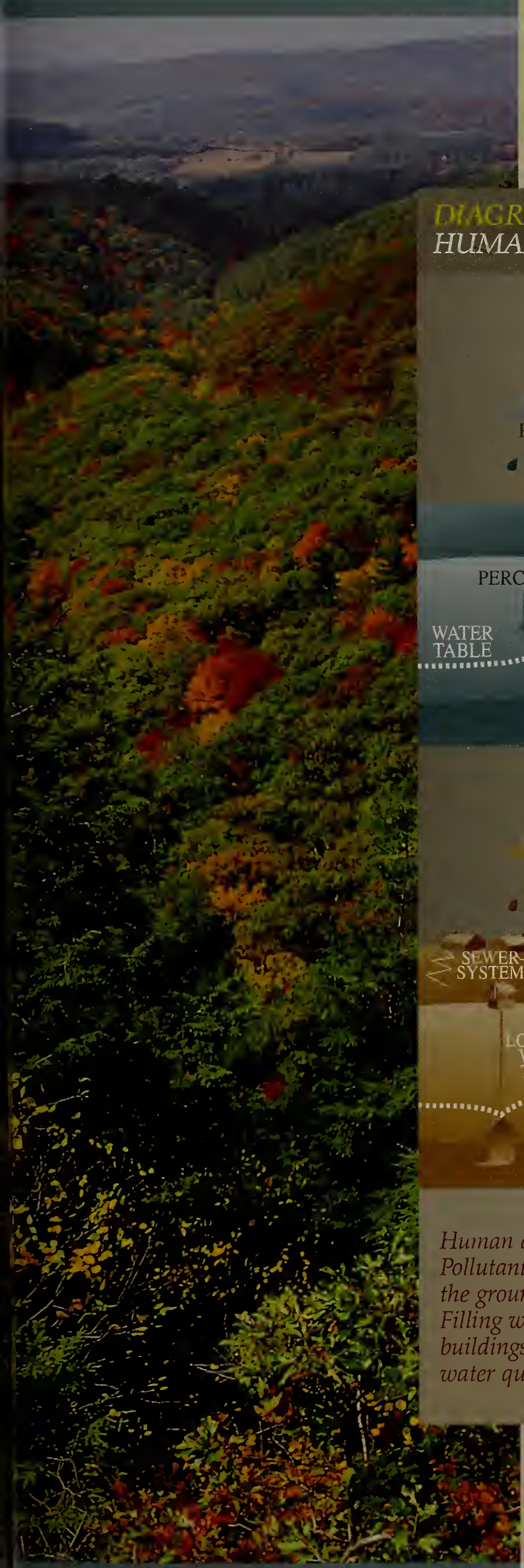
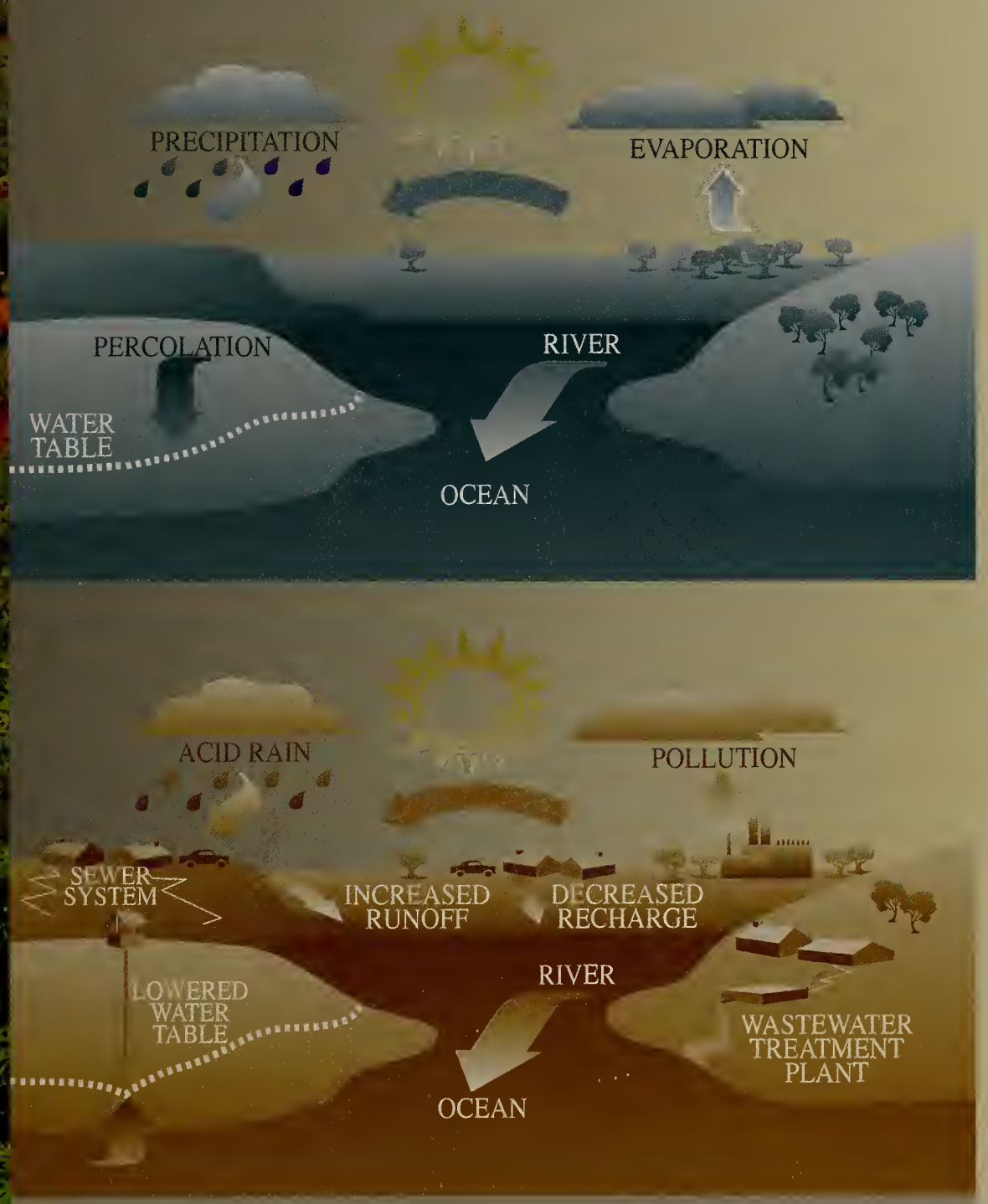


DIAGRAM 3.1:
HUMAN INTERFERENCE WITH THE WATER CYCLE



Source: Adapted from Charles River Watershed Association

Human activities harm the water cycle in many different ways. Pollutants are discharged directly into water bodies, wash off the ground in nonpoint source runoff, or fall from the air. Filling wetlands, damming rivers, and paving the ground with buildings, roads, and other impervious surfaces affects both water quality and quantity.

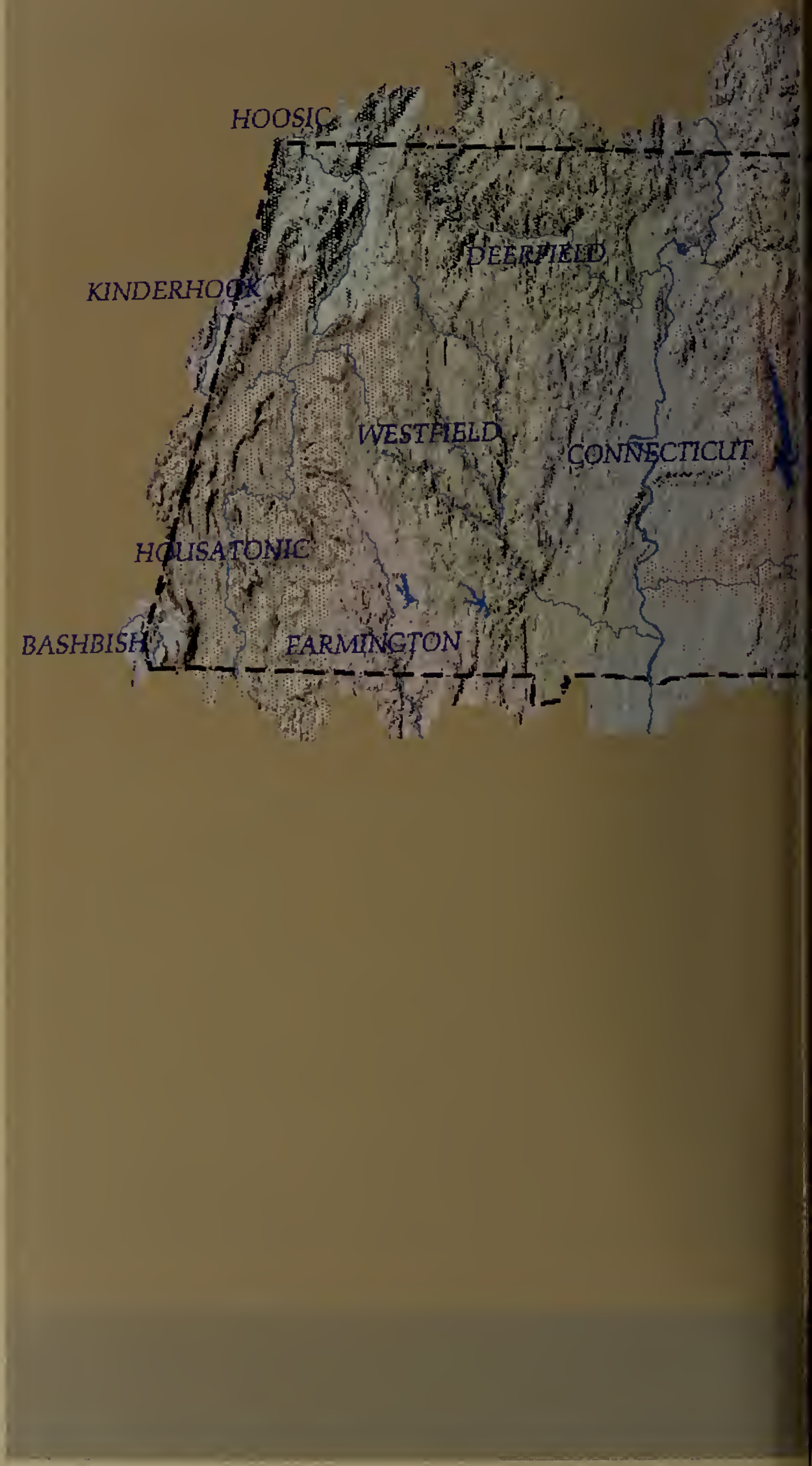
3.

Massachusetts has over 2,000 named rivers and streams, with a total length of more than 10,700 miles. On the steeper slopes of the uplands the rivers run faster and straighter, carving V-shaped valleys with a jumble of boulders and stones in the streambed. Lowland rivers take a slower, more meandering course, spilling over their banks during the spring floods to lay down rich deposits of soil that provide some of the best farmlands in the state.

Open water covers about 3% of the state's surface, most of it in the 1,638 lakes and ponds that measure over ten acres. These range from sandy ponds in the southeast, often shaped by leftover chunks of glacier, to lakes and man-made reservoirs in the folds of the hills.

Groundwater is a crucial, but invisible, part of our water resources. Rain and snowmelt percolate down from the surface to a depth where the water fills up open pores in the soil or rock. The depth and amount of groundwater, the direction in which it flows, and the ability to tap it through wells, are all dictated by the nature of the soils and rocks in which it is found. Approximately 16% of the state lies above groundwater aquifers located in sandy or gravel deposits that can provide drinking water at a high or medium yield rate. These areas include most of the southeast, the Cape, and the Islands, as well as much of the Connecticut Valley and other plains and valleys.

MAP 3.1: WATERSHEDS OF MASSACHUSETTS



Source: MassGIS

hills organize the Massachusetts landscape into 28 distinct watersheds: large areas in which runoff streams feed into a single river or coastal water. EOEA's watershed initiative treats each watershed self-sustaining unit.

3.

DRINKING WATER: PROTECTING THE SOURCES.

More than half of all Massachusetts residents, 3.3 million people, draw their drinking water from surface waters: rivers, lakes, and man-made reservoirs. Of that number, 2.5 million people in Boston and other eastern Massachusetts communities are customers of the Massachusetts Water Resources Authority (MWRA). Their drinking water travels from the Quabbin and Wachusett Reservoirs halfway across the state via pipe, aqueduct, and tunnel. Completed in 1938, the 25,000-acre Quabbin is one of the largest drinking water reservoirs in the nation. Other cities and towns rely on smaller local reservoirs, or draw water from major rivers like the Connecticut and the Merrimack. The other 2.7 million citizens rely on public or private wells that tap groundwater aquifers.

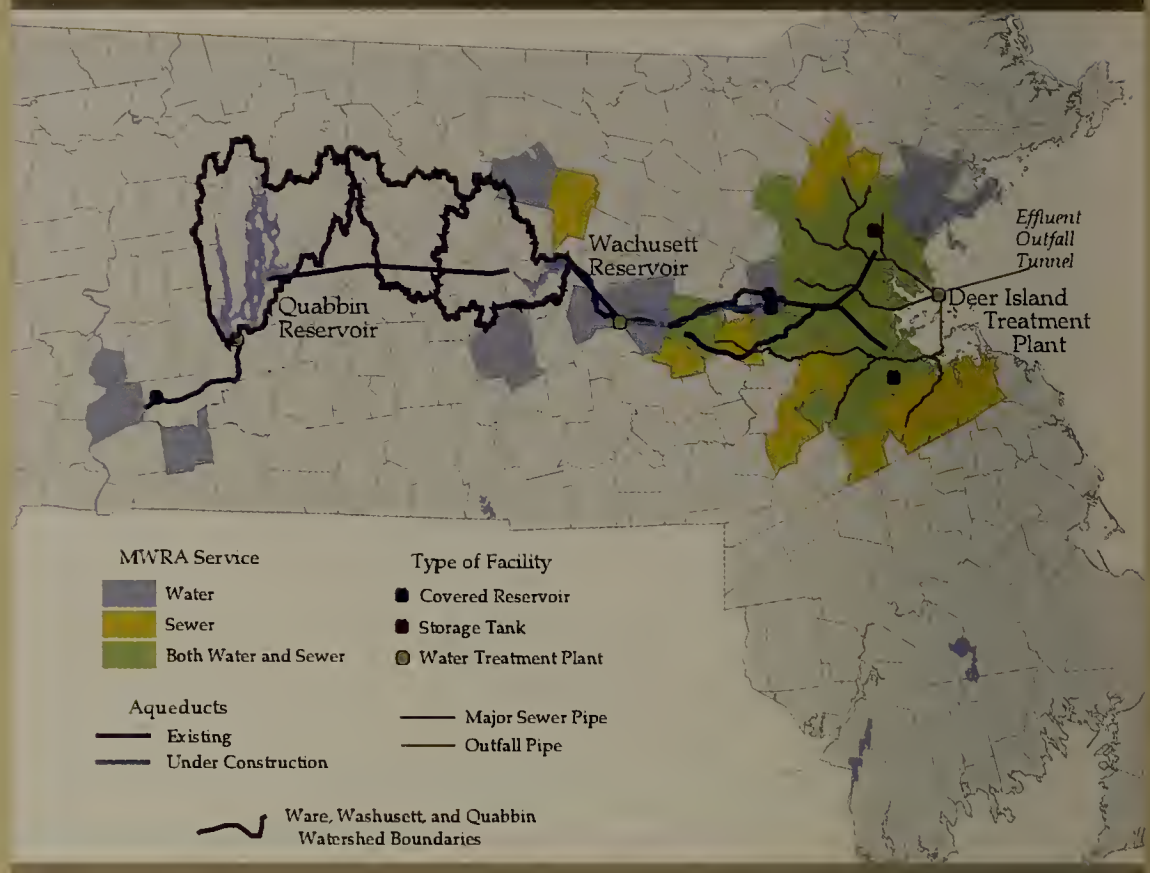
Federal and state laws require tough protections to ensure the safety of our drinking water. These protections start with the land that surrounds or overlies the source. The watersheds of reservoirs and other surface water sources, if not publicly owned, are subject to stringent land-use restrictions. Similarly, Department of Environmental Protection (DEP) regulations require that the area immediately around each public drinking well or withdrawal point must be publicly owned, and surrounded by a zone within which land uses are strictly controlled. By the end of 1999, DEP had reviewed protections for water supplies serving 86% of the population. To ensure that citizens receive good information about local water quality, starting in 1999 the federal Safe Drinking Water Act requires all communities serving over 5,000 customers to provide all of their customers with annual Consumer Confidence Reports.

The protection of groundwater requires special vigilance. Past contamination from intentional dumping or accidental spills can affect groundwater. It may take years or even decades for pollutants to leach down through the soil. Once groundwater is contaminated, however, it may take decades more of "pumping and treating" before the water is drinkable again. Over the past 20 years, contamination has caused 51 communities in Massachusetts to remove at least one drinking water well from use. Culprits have included unlawful dumping, accidental spills, failed septic systems, and landfill leachate.

One potential threat to groundwater is leaks from underground storage tanks (USTs). The digging at gas stations during the past few years is evidence of compliance with new federal and state UST regulations. By the end of 1998, all existing single-walled metal tanks had been removed, and replaced by safer new fiberglass tanks.

There has been recent concern about the threat to groundwater posed by the gasoline additive MTBE. Although it provides significant benefits in reducing air pollution, it dissolves easily in water and can travel relatively quickly. Massachusetts is working with other New England states to find a substitute additive. However, we continue to enforce tough UST and water monitoring requirements to reduce the risk of MTBE contamination.

MAP 3.2: THE MWRA SYSTEM



Source. MWRA

The MWRA serves almost half of the population of Massachusetts, 2.5 million people. Their drinking water travels halfway across the state, from the Quabbin and Wachusett Reservoirs. Wastewater is treated at the new Deer Island Treatment Plant, and then discharged into the ocean.

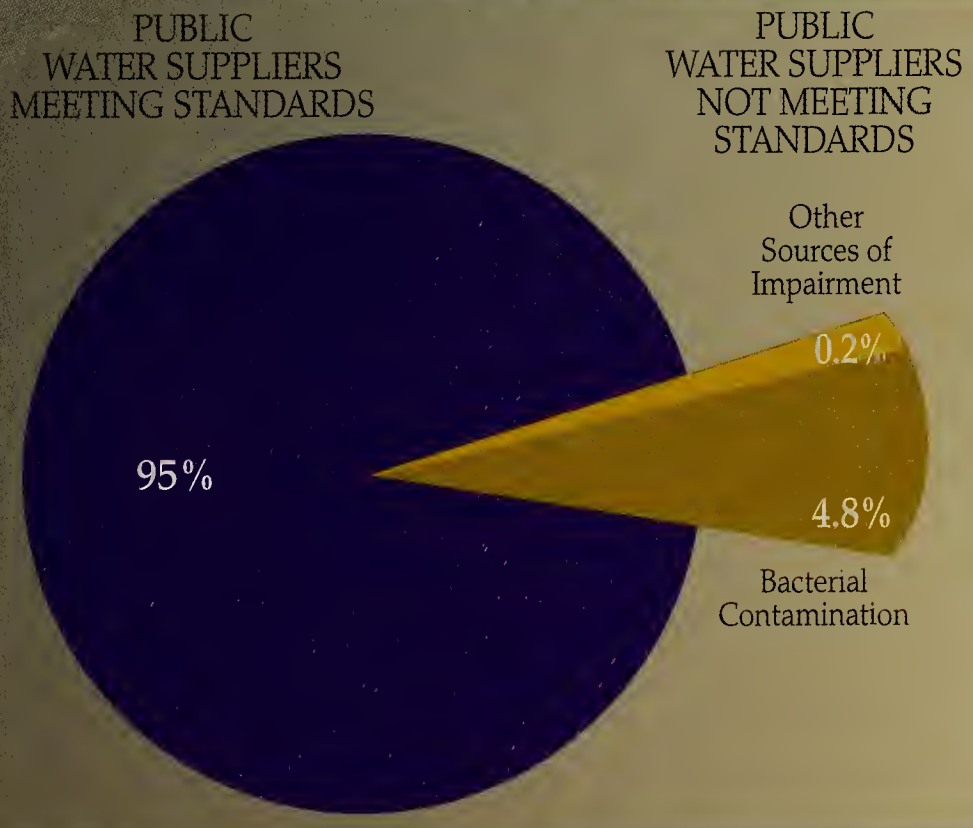
PROTECTING DRINKING WATER SOURCES

The 25,000 acre Quabbin Reservoir and its protected 60,000 acre watershed provide clean water to 2.5 million residents in Massachusetts, and serve as valuable habitat for many plant and animal species – including the state's largest bald eagle population. (Photo: MDC)

The protection of water supply lands provides other environmental benefits. Water supply lands serve as valuable wildlife habitat. The 60,000 acres surrounding the Quabbin, an area managed by the Metropolitan District Commission (MDC), support the largest population of bald eagles in the Northeast outside of Maine. With careful management, these areas can support hiking, nature study, and other kinds of recreation.

We must also protect areas that could serve as water supplies in the future – particularly land overlying potentially productive aquifers – through acquisition, zoning, or other regulations that restrict incompatible uses. The recent creation of the Upper Cape Water Supply Reserve, described in Chapter 8, sets aside 15,000 acres of land on Cape Cod to meet current and future regional water needs.

ENVIRONMENTAL INDICATOR 3.1: SAFE DRINKING WATER SUPPLIES



Source: DEP

Federal and state laws require tough protections for the land over and around drinking water supplies. To date, DEP has reviewed protection plans for supplies serving 86% of the population.

DIRTY WATER TO . . .

Starting in the nineteenth century, industrial and human waste discharges polluted many rivers, such as the Nashua River, shown here in the 1970s, making the water unfit for drinking, fishing, or swimming. (Photo: EOEA)

KEEPING RIVERS, LAKES, AND BEACHES FISHABLE AND SWIMMABLE

Water quality affects the use of rivers, lakes, and coasts for fishing, swimming, and other recreational activities, and determines whether these waters provide healthy environments for plants and animals. Industries, commercial operations, and households can release pollutants that threaten human health — directly, when someone drinks or swims in the water, or indirectly, if pollutants poison the fish, shellfish, and waterfowl that someone eats. Although dissolved pollutants move with the water, other pollutants sink down to contaminate bottom sediments.

Human releases of organic wastes, fertilizers, and other nutrient-rich materials can also harm water quality, by artificially stimulating the growth of algae and bacteria. These organisms, as well as other pollutants, reduce the level of dissolved oxygen in the water, harming fish and other life.

For too long, the fast-moving water of our rivers and the tidal waters of coastal harbors were seen as self-cleaning outlets for industrial and human wastes. As cities grew, and public water supplies and indoor plumbing became generally available, civil engineers designed and built miles

of underground sewers. In Boston alone there were 223 miles of public sewers by 1885, serving over 100,000 flush toilets.

Federal and state Clean Water laws, passed in the 1970s, set up the regulatory framework for regulating "end-of-the-pipe" point sources, chiefly factories and municipal treatment plants, to reduce the amount of pollution discharged. At the same time, government subsidies supported the construction of new municipal wastewater treatment plants throughout Massachusetts. Older plants relied on primary treatment, using gravity to separate out floating scum and sinking sludge from the wastewater. The newer plants also use secondary treatment, which removes 85% to 95% of the remaining pollutants.

Today, 139 fully regulated public treatment plants serve almost three-quarters of the Massachusetts population. The largest of these plants, on Deer Island in Boston Harbor, began providing secondary treatment for the MWRA system in 1997. The rest of the population relies on smaller treatment plants, or on private septic systems regulated under Title 5. The use of smaller decentralized systems is likely to increase as we learn more about how large centralized sewer systems can affect the water budget of individual watersheds.

CLEAN WATER

Strict regulation of point source pollution under federal and state clean water laws has restored many rivers to healthy conditions. Nonpoint source pollution from stormwater and agricultural runoff prevents rivers from fully achieving environmental standards. (Photo: EOEA)

3.

THE CHALLENGE OF POLLUTED STORMWATER

As we succeed in cleaning up the point sources of water pollution, more and more of the energy of EOEA's Watershed Initiative is being focused on "nonpoint" sources. These are defined as the collective effect of daily activities that release oils, fertilizers, and other pollutants on the land, to be washed into our rivers, lakes, and coastal waters by rainstorms and melting snow.

Human alteration of the landscape has worsened the polluting effects of stormwater runoff. Buildings, roads, parking lots, and other impervious surfaces cover more than half of the ground in many cities and towns. Water that once seeped into the ground, to be absorbed and naturally cleansed by vegetation and soil, is now collected in artificial channels, picking up pollutants on its way into water bodies. In more developed areas, the outfall pipes of storm sewers capture and concentrate all the pollutants

STORMWATER RUNOFF

Impervious surfaces such as roads and parking lots channel stormwater into sewer systems, contaminating the water with oil and other pollutants and preventing the recharge of groundwater aquifers. (Photo: EOEA)

of an entire sub-watershed. The loss of recharge to the soil also reduces the amount of groundwater available for drinking water and for the base flow of rivers and streams.

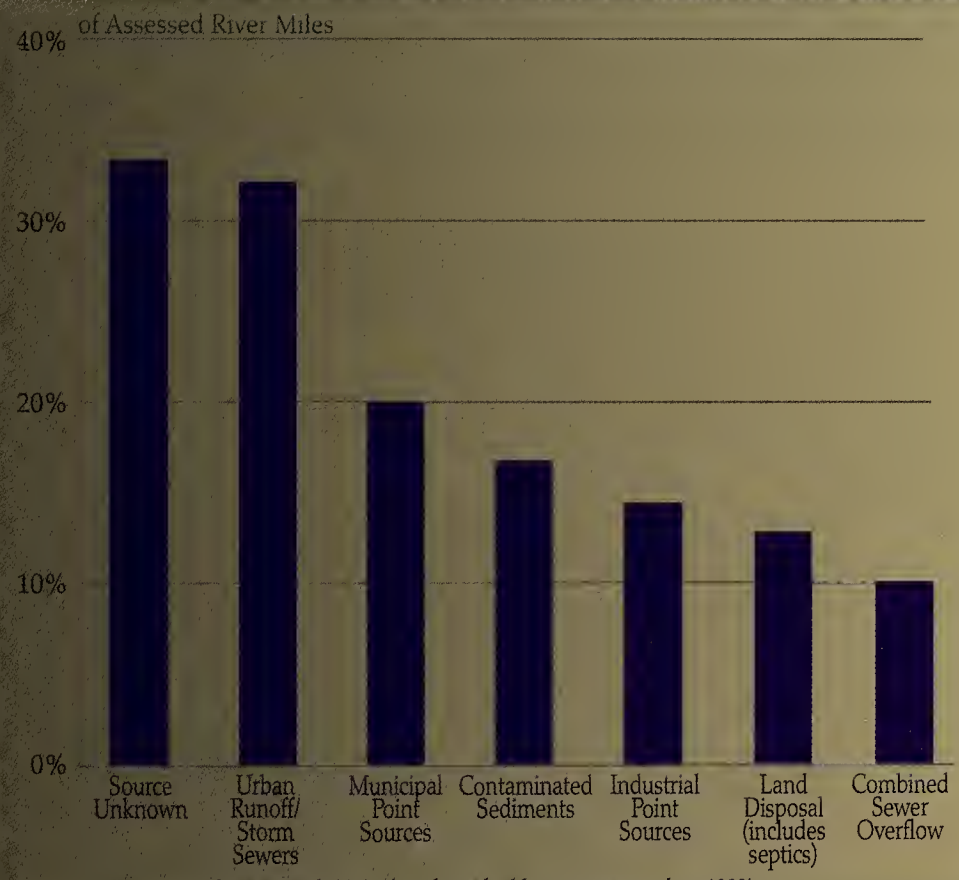
In many of our older, larger cities the problem is made still worse by combined sewer overflow (CSO) systems, in which stormwater and sewage flow into the same pipe. Although such systems can work in dry weather, during storms the pipes cannot handle the high-volume flows, causing the direct release of untreated wastewater into rivers and harbors. Planning or construction of new CSO control systems is now underway in communities all around Boston Harbor, along the Charles, Mystic, Merrimack, and Connecticut Rivers, and in southeastern Massachusetts. The completion of these new systems, which will take many years and cost hundreds of millions of dollars, will reduce the releases from CSOs by more than 95%.

Water quality statistics reflect the changing nature of the problems we face. In our major rivers, urban stormwater runoff and storm sewers are the biggest problem, affecting one-third of all tested waters. Municipal point sources (treatment plants) affected 20%, and CSOs affected an additional 10%.

Lakes and ponds suffer from a related set of problems. The pollutants and nutrients washing down the slopes of the watershed tend to collect in their waters, and in the sediments at their bottoms. Nutrient-fed algae and bacteria reduce the oxygen level in the water body. The slow-moving waters of lakes and ponds are also more vulnerable to the invasion of non-native plants and animals, which affect nearly half of all tested lakes. Human interference with the watersheds speeds up the process of "eutrophication," by which erosion, sedimentation, and wetland plant growth can transform a pond first into a marsh and finally into solid land. Instead of naturally occurring over centuries, eutrophication may occur in only ten or twenty years due to human causes.

To address these problems, the federal Clean Water Act requires the analysis of the "Total Maximum Daily Load" (TMDL) for each substandard waterbody. This analysis will determine the total amount of pollution that a river or lake can support and still meet state water quality standards. If a waterbody exceeds its TMDL, the state will develop a plan to reduce pollution from new and existing point and nonpoint sources further. There are over 1,000 river segments, lakes, and ponds in Massachusetts for which we need to develop TMDLs within the next 12 to 15 years. This work, although daunting, is necessary if we are to make our waters fully fishable and swimmable.

ENVIRONMENTAL INDICATOR 3.2: MAJOR CAUSES OF WATER POLLUTION IN RIVERS



1,495 river miles assessed, 18% of total; total adds up to greater than 100%

Source: DEP, 1998 305B Report

As we succeed in cleaning up discharges from factories and other point sources, nonpoint pollution from stormwater runoff has become the biggest water quality problem in major rivers.

CLEANING UP BOSTON HARBOR

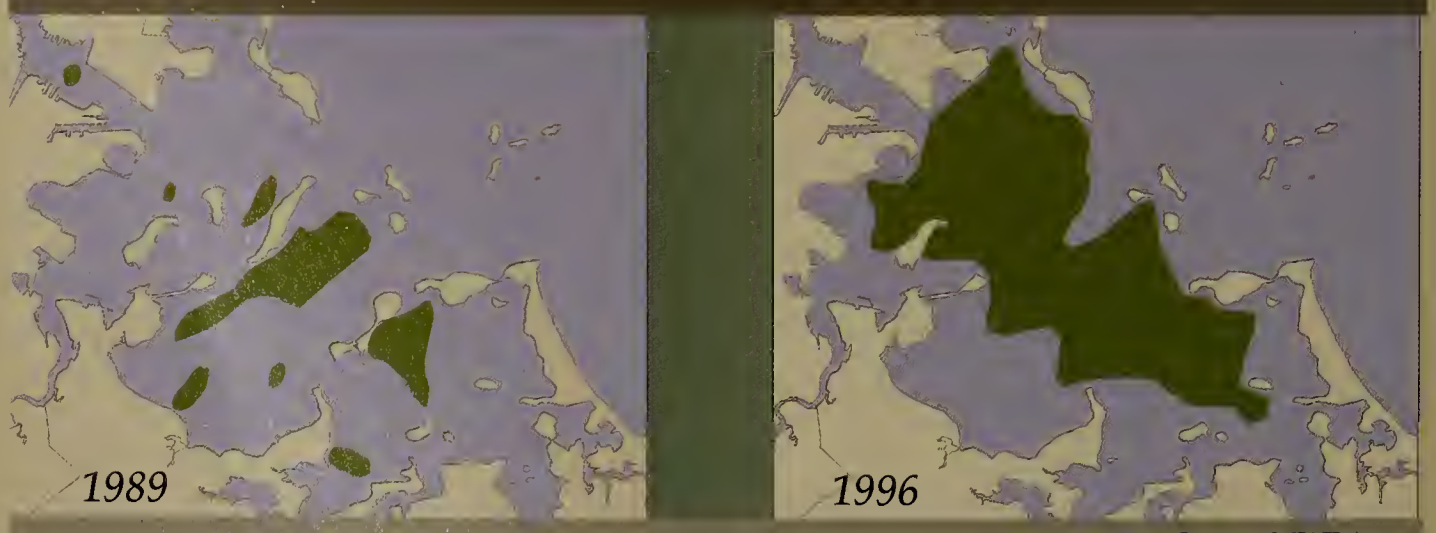
The MWRA's $3.8 billion Boston Harbor cleanup project is restoring the environmental health of Boston Harbor, one of the great natural resources of Massachusetts, after decades of pollution and neglect. The harbor is a protected estuary measuring 50 square miles, bounded by 180 miles of shoreline, and dotted with 30 islands. Today marine life has returned, and beaches are swimmable again. Thanks to this ambitious program of environmental restoration, the harbor can now reach its full potential for recreational use and commercial development.

The harbor cleanup began with lawsuits by the City of Quincy, the Conservation Law Foundation, and the U.S. Department of Justice, which charged violations of clean water laws in order to stop the dumping of raw sewage that had gone on since colonial times. In 1986 federal judge David Mazzonne ordered the newly-formed MWRA to stop polluting the harbor by constructing primary and secondary treatment facilities.

To comply with the judge's order, the MWRA has built the nation's second-largest sewage treatment facility on Deer Island to treat the wastes of 43 communities. Since the new Deer Island plant became operational in 1997, discharges of solids in the harbor have been reduced by 75%. The final element of the system, a nine-mile-long outfall pipe that will diffuse the treated wastewater into Massachusetts Bay, should go on-line soon.

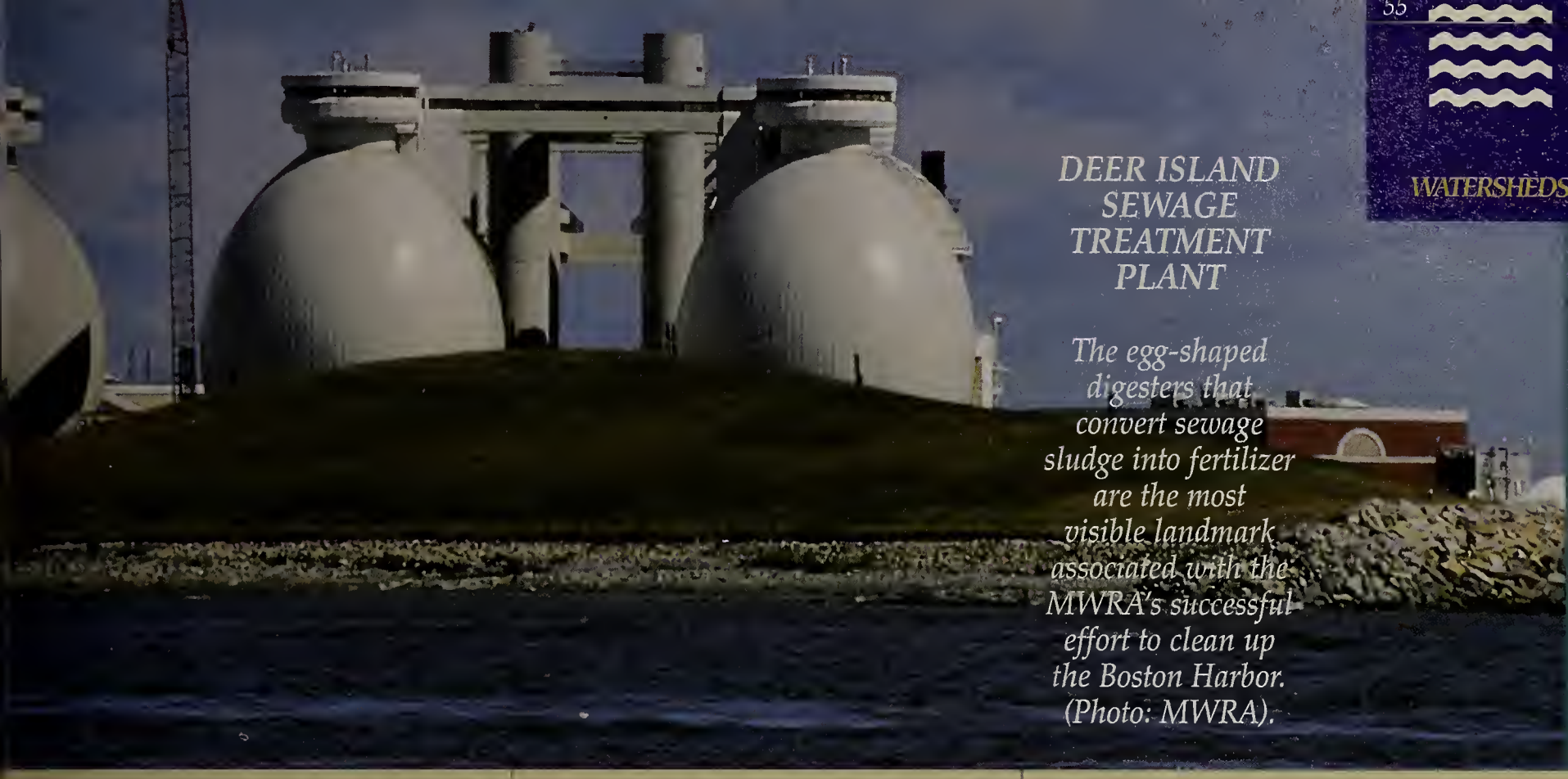
The MWRA is also working to remove the second major source of pollution from the harbor: the mixture of rainwater and sewage that is dumped during storms by the 81 regional CSOs. Closures and diver-

MAP 3.3: LIFE RETURNING TO BOSTON HARBOR



Source: MWRA

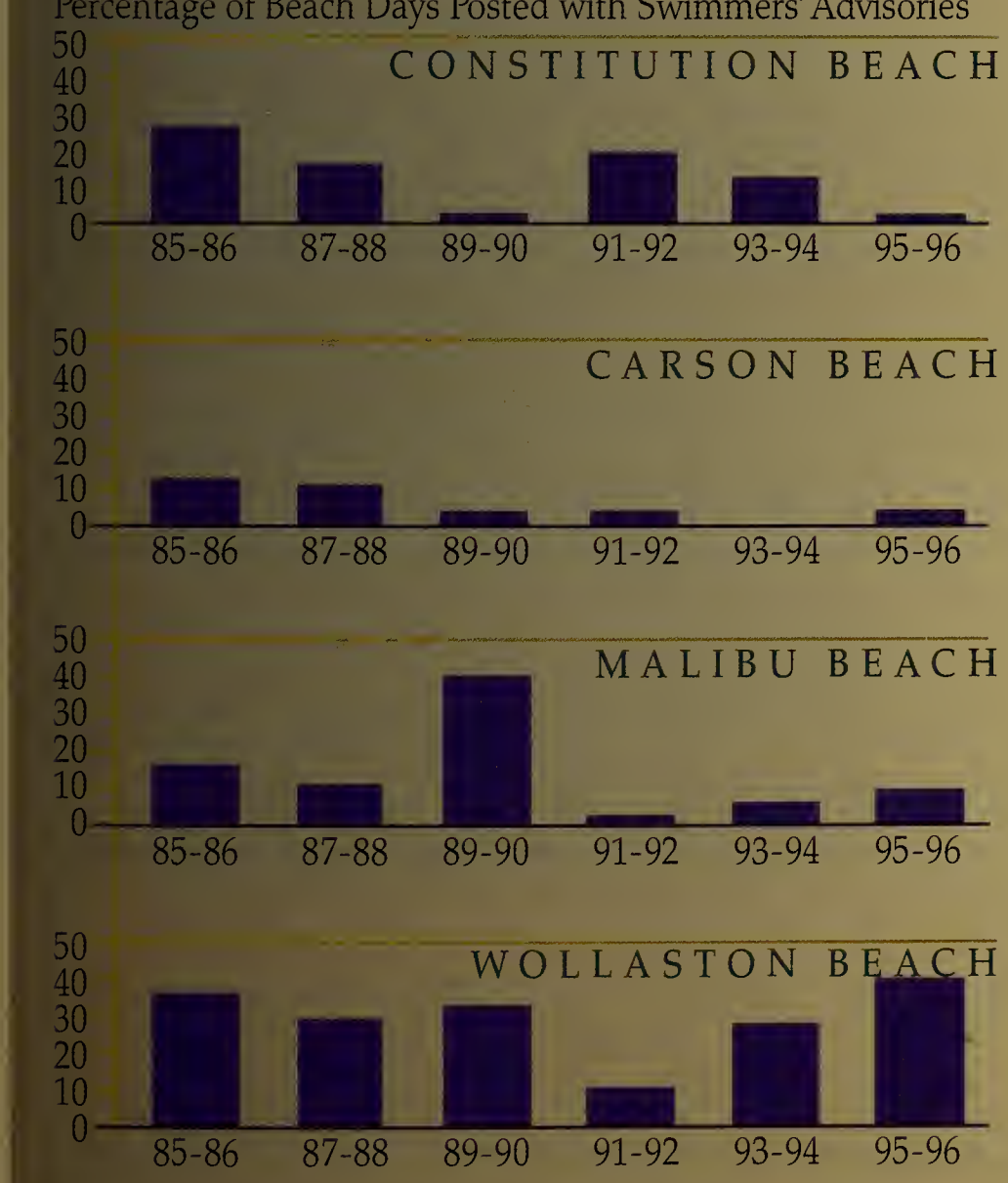
The spread of ampelisca tubemats, a small pollution-intolerant crustacean, across the harbor floor, shows the dramatic improvement in water quality produced by the MWRA cleanup project.



DEER ISLAND SEWAGE TREATMENT PLANT

The egg-shaped digesters that convert sewage sludge into fertilizer are the most visible landmark associated with the MWRA's successful effort to clean up the Boston Harbor. (Photo: MWRA).

ENVIRONMENTAL INDICATOR 3.3: CLEANER WATER AT BOSTON HARBOR BEACHES



Source: MWRA

Thanks to the cleanup effort, the harbor is regaining its full potential for recreational use.

sions will reduce the total flow from CSOs by 84%, compared with 1988 levels. The remaining flows will be screened and disinfected.

As sewer discharges have dropped, marine life has revived. Bottom-dwelling crustaceans and seagrasses have spread over the harbor floor; seals and porpoises can be seen regularly.

The harbor cleanup also brings recreational and economic benefits to citizens of the Boston region and the entire state. With bacteria levels within safe limits, beaches are open for swimming. New proposals for waterfront development all around the harbor will be guided by municipal harbor plans and DEP's Chapter 91 regulations (see Chapter 7). In 1996 Congress designated the harbor islands as a unique National Park Area (see Chapter 8).

3.

VERNAL POOL NO. 1854
A LABOR OF LOVE OF MUD

Eight-year-old John Moore still remembers the sound of "peepers," those tiny frogs that herald the arrival of spring, coming from somewhere behind his house early last year. "We thought they were ducks," he said of the incessant chattering.

John found out that the peepers and myriad other life forms lived in a vernal pool, a small depression that fills with water each spring but is dry much of the rest of the year.

After a lot of work by John and his mother, Deborah Moore, the pool is now registered with the Division of Fisheries and Wildlife's (DFW) Natural Heritage and Endangered Species Program, as Vernal Pool No. 1854, and it will be permanently protected.

"I did just about all of the work," John said. "I measured the size of the pool and everything."

The third grader spent a lot of time examining wood frogs, mole salamanders, caddis fly larvae, and fingernail clams. He even convinced his parents to buy him a pair of hip boots.

"It's kind of fun and it looks kind of neat when you look at them up close," John said of examining the pool's life forms. "Everyone was interested in going and getting tadpoles and then putting them back."

John and his mother found the benchmark species that denote a vernal pool, took pictures, drew a map, developed a timeline describing the pool's stages, and filled out a certification application.

"He got really interested. He was out there every day," Ms. Moore said. "It was loaded with a lot of life. We watched it through all of its stages."

John first learned about vernal pools at a talk sponsored by the Holliston Conservation Commission the year before. When one of the sponsors took him out on a local pool in a kayak, John was fascinated.

You can bet that this spring, John will be back out there standing watch over Vernal Pool No. 1854. It could have no better friend.

REVERSING THE LOSS OF WETLANDS

Massachusetts law protects the full range of wetlands, including rivers, streams, lakes, ponds, and the freshwater and saltwater marshes and swamps that border those waters. Protected wetlands also include barrier beaches and sand dunes along the coast; all low-lying lands that are subject to periodic flooding by rivers or the ocean; riverfront areas; and vernal pools. Under the state Wetlands Protection Act, all alterations of wetlands must be reviewed and approved by the local Conservation Commission. DEP must review all appeals and approve all variances. Large wetlands alterations also require federal permits from the U.S. Army Corps of Engineers. About 570,000 acres, 12% of the state's total area, are classified as protected wetlands.

Wetlands need protection because they help watersheds in many different ways. Marshes and swamps improve water quality by filtering out sediments and pollutants. Marshes, swamps, and other low-lying areas protect adjacent communities from damaging floods by capturing high waters and then slowly releasing them. This process of capturing and releasing stormwater also helps maintain the steady base flow of rivers and streams during dry periods, and it serves to recharge underground aquifers. The flexible, self-repairing natural defenses of coastal barrier beaches and dunes buffer low-lying communities against the ocean waves of hurricanes and nor'easters.

Wetlands are also crucial to the health of natural communities.

ENVIRONMENTAL INDICATOR 3.4:
WETLAND LOSSES, 1780s - 1980s

Source: U.S. Fish and Wildlife Service

28% of the state's wetlands have been destroyed since colonial times, but environmental laws have curtailed and nearly stopped the net loss of wetlands.

Acre for acre, there is more life in the spawning fish, shellfish, and other creatures in a coastal salt marsh than in any other environment found in Massachusetts — and freshwater swamps and marshes are not far behind. This abundance of life attracts some of our most dramatic wildlife, including herons, seals, ospreys, and bald eagles. Although it is difficult to place a dollar value on natural resources, a Massachusetts Audubon Society study estimates that each acre of wetland, in terms of prevention of floods and pollution, protection of water supplies and wildlife, and recreational value, is worth approximately $170,000.

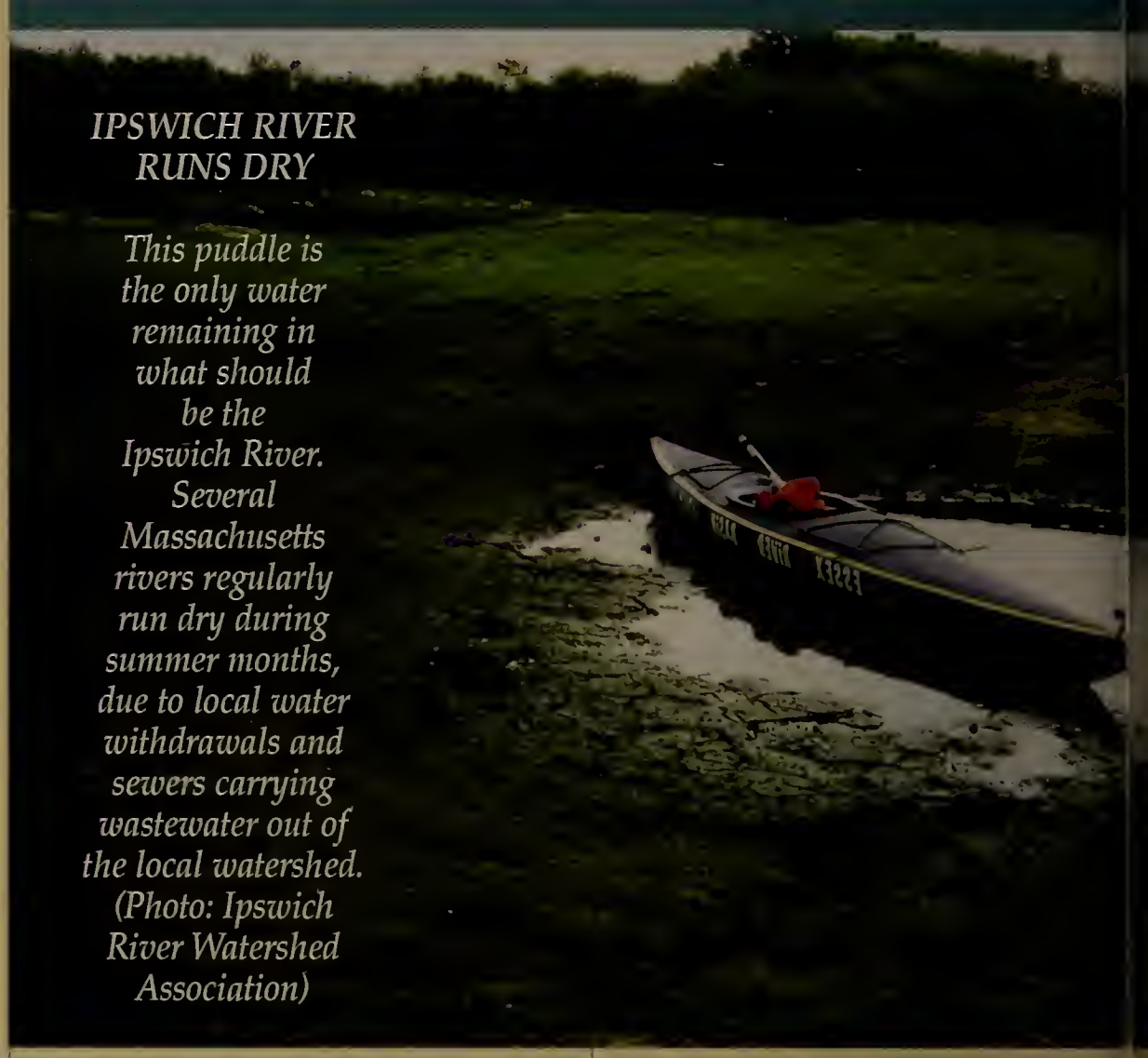
The appreciation of wetlands is relatively recent. For years they were viewed as useless, disease-ridden places, to be diked or filled. No one knows for sure exactly how much we have lost, but it is estimated that 28% of the wetlands in the state have disappeared since colonial times.

Now that government protections have curtailed the net loss of existing wetlands, the challenge for the future is to reverse the trend and start to restore wetlands. Many of our existing wetlands have been damaged by ditching, dumping,polluted runoff, and other causes. Wetland restoration programs, including the new Corporate Wetlands Restoration Partnership, are now underway in many different watersheds. They seek to restore the ecological function of existing wetlands – and are attempting to create new wetlands.

3.

BALANCING WATER BUDGETS BY KEEPING WATER LOCAL

A properly functioning natural water cycle ensures that the water budget in each watershed is in balance: the total amount of water lost does not exceed the amount of new water coming in. Wetlands filling, impervious surfaces, sewering, and other forms of human interference with the water cycle are depriving the rivers, lakes, wetlands, and groundwater aquifers in many watersheds of the flows they need to recharge themselves. Sanitary sewers take water that was originally pumped out of the ground and send it to discharge points that may be many miles away, downstream, or in a different watershed altogether.



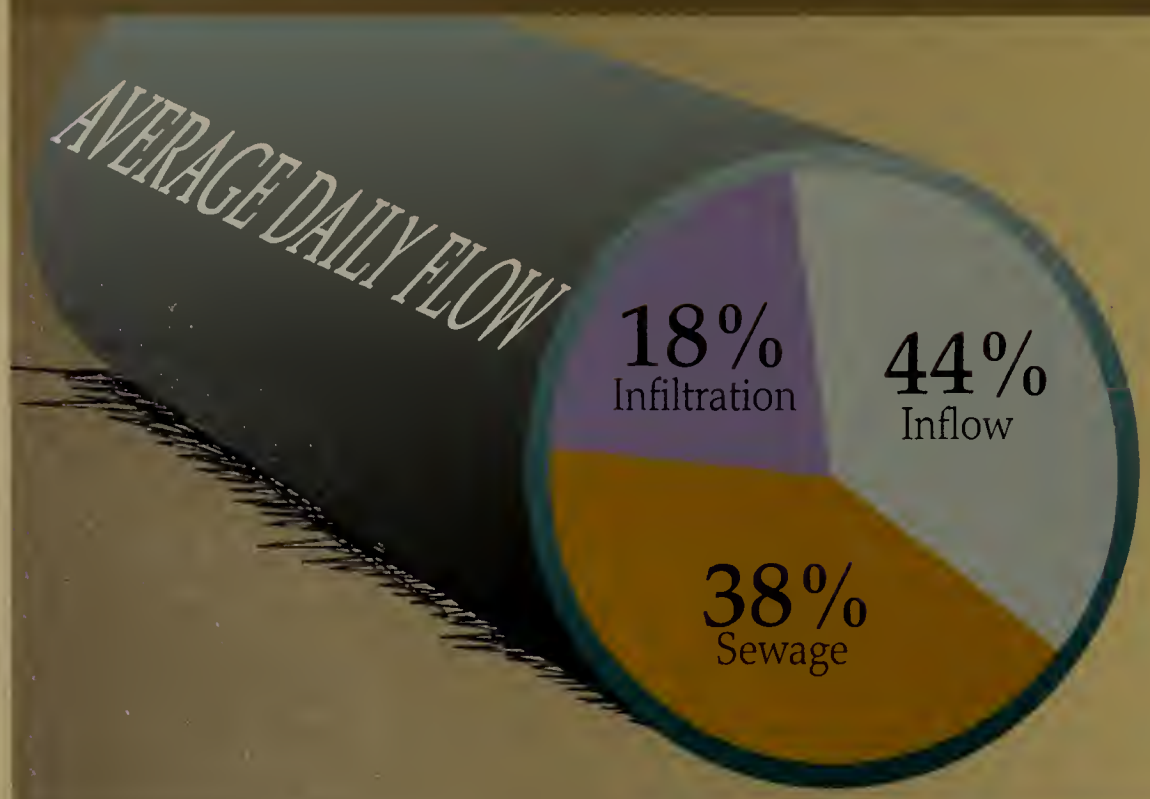
IPSWICH RIVER RUNS DRY

This puddle is the only water remaining in what should be the Ipswich River. Several Massachusetts rivers regularly run dry during summer months, due to local water withdrawals and sewers carrying wastewater out of the local watershed. (Photo: Ipswich River Watershed Association)

Making the problems still worse, much of the water running in sanitary sewers got there through inflow (sump pumps and poorly constructed or maintained surface drains that direct stormwater into sewer systems) or infiltration (cracks and leaks in the pipes, through which groundwater is sucked away). Inflow and infiltration (commonly known as "I&I") also reduces the ability of sewer systems to carry the flows for which they were designed. More than half of the water in the sanitary sewer lines of the MWRA system is actually clean water that is being treated at Deer Island and then discharged into the ocean.

One can see the effects of unbalanced water budgets in many watersheds, particularly those in the eastern part of the state that are affected by rapid growth. As new development occurs, all the stresses on water resources increase: greater demands for consumption, risks of spills, polluted runoff, degraded wetlands, I&I, sewers, and larger areas of impervious surfaces. Rivers like the Ipswich and the upper Charles are already running dry or dangerously low during the summer. In towns that depend

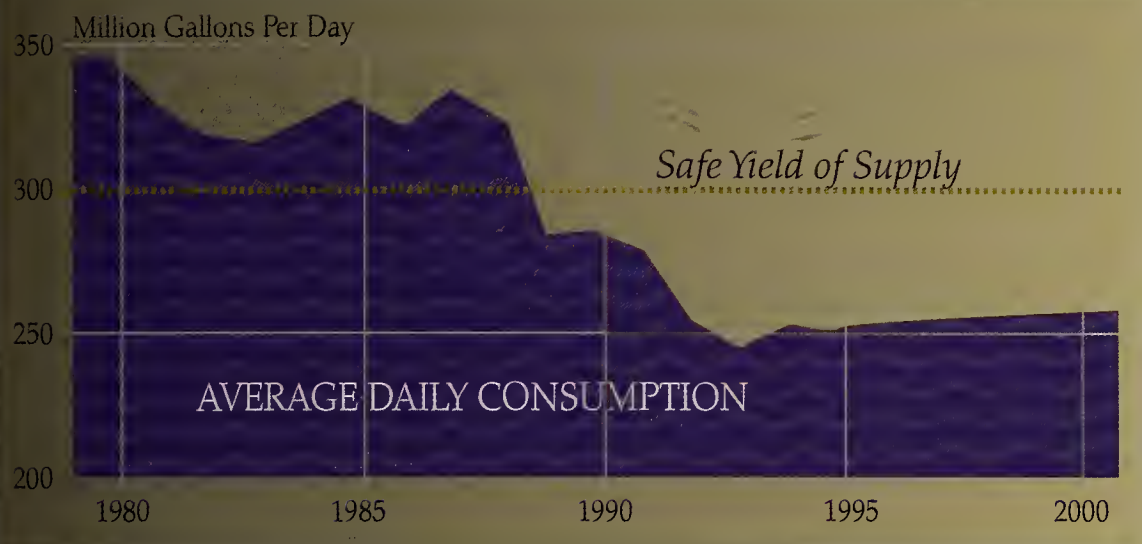
ENVIRONMENTAL INDICATOR 3.5:
SEWER INFLOW AND INFILTRATION RATES IN MWRA COMMUNITIES



Source: MWRA

More than half of the flow in most sewers is actually clean water, due to inflow from surface drains and infiltration from leaky pipes. I&I removes groundwater and reduces sewer capacity.

ENVIRONMENTAL INDICATOR 3.6:
MWRA WATER USE TRENDS, 1980 - 2000



Source: MWRA

Water conservation measures, from fixing leaky pipes to installing low-flow toilets and showerheads, have reduced per capita water consumption.

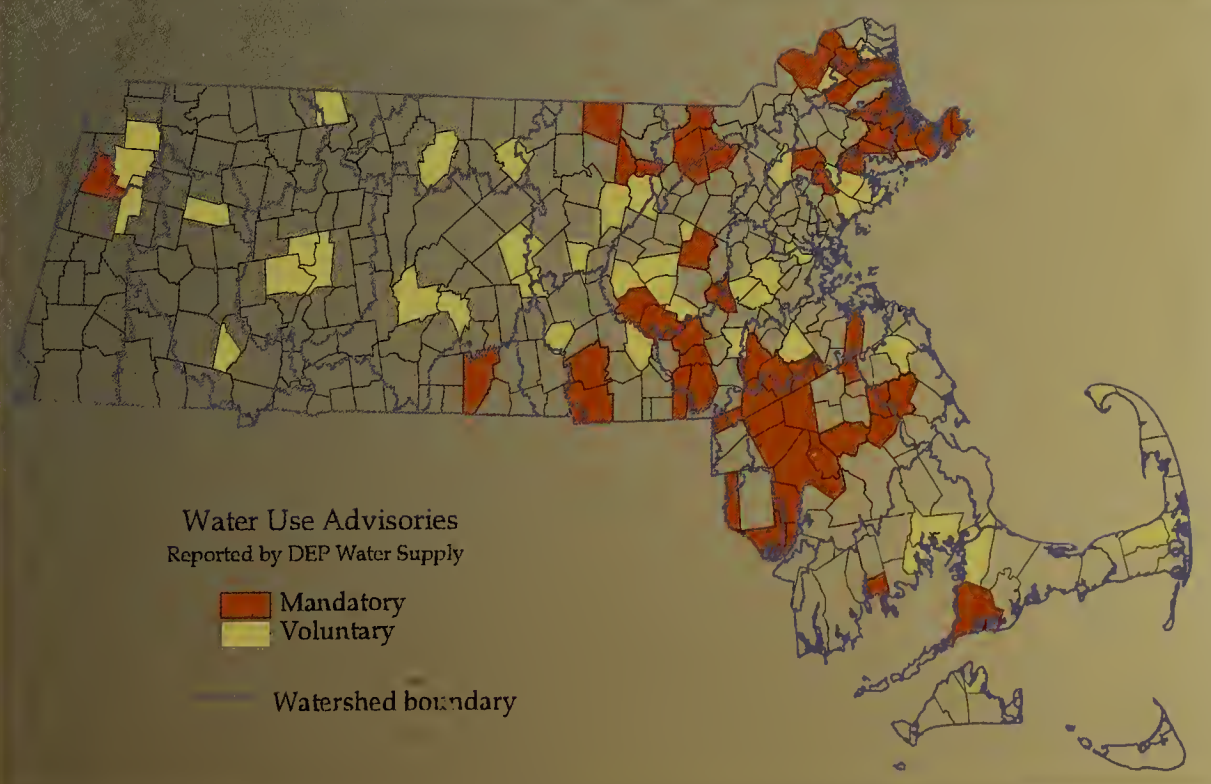
on groundwater drinking wells, the inability of stormwater to infiltrate the ground and recharge the aquifers can affect the ability to meet water needs – particularly in the summer, when peak demands can double or even triple.

There are some hopeful signs. A wide range of water conservation measures, from fixing leaky water pipes to new building codes that require low-flow toilets and showerheads, have reduced the per-capita rate of water consumption in recent years, both statewide and within the MWRA system. But this general trend is not enough to alleviate the localized stresses on individual watersheds.

EOEA's Watershed Initiative is developing management plans for each of the 28 major watersheds. To carry out the goal of balancing water budgets by "keeping water local," the state Water Resources Commission must review and approve all water transfers between major watersheds. Within individual communities or watersheds, DEP and the state MEPA Office are requiring that new sewering projects fit into comprehensive town-wide strategies for wastewater management.

Many towns are grappling with these tough issues. Keeping wastewater local after it has been cleaned, to recharge rivers, lakes, and aquifers, often requires a mixture of smaller plants and individual or shared septic systems, along with larger town-wide plants. Communities along the Assabet River are developing a multi-town approach to wastewater issues. The towns of Bellingham and Holliston in the upper Charles basin are looking very broadly at a unified approach to water supplies, wastewater management, and the effects of land use on stormwater flows and water recharge. We will need to pursue these kinds of broad-based approaches in coming years to maintain the health of each watershed.

MAP 3.4:
COMMUNITIES ISSUING WATER USE ADVISORIES IN 1999



Source: DEP

Although Massachusetts is a water-rich state, rapid growth has unbalanced the water budget in many river basins, including the Ipswich, upper Charles, and Taunton.

3.

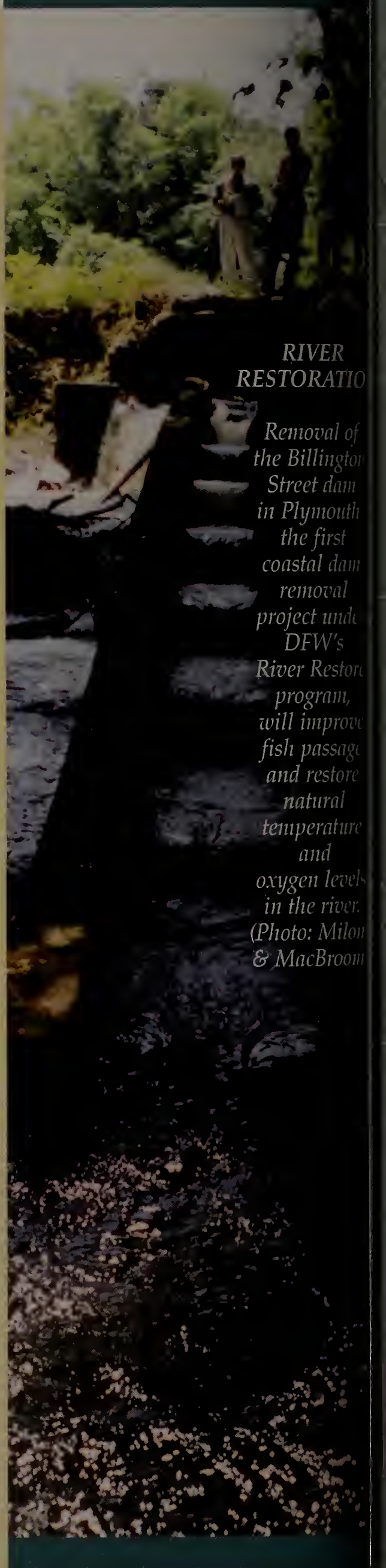
RIVERS RUNNING FREE

The environmental and recreational functions that rivers provide can be seriously affected by development activities in bordering upland areas, such as cutting greenery, paving the land, and applying pesticides. In 1996 the legislature, under the leadership of then-Senator Bob Durand, passed the Rivers Protection Act, the nation's first comprehensive rivers protection program. Local conservation commissions now review activities within a zone extending 200 feet from the banks of each perennial river and stream.

The removal of unneeded dams can help restore the ecological functions of many Massachusetts rivers. When a river is dammed, it affects the natural environment in several ways. Fish and other aquatic life are harmed — both because they can no longer swim freely upstream and down, and because the temperature and oxygen level of the still water behind a dam may be far less hospitable than conditions in a free-flowing river. The problem is most acute for salmon, herring, alewives, and other anadromous fish, which must swim upriver from the sea to spawn in freshwater. Even a well-maintained fish ladder hinders their life cycle. Dams also affect the downstream ecology, flattening out the natural cycle of high- and low-flow periods, and robbing valley soils of valuable nutrients that would otherwise be deposited by spring floods.

There are approximately 3,000 dams on the rivers of Massachusetts: more than one dam for every four miles of river. Most of these dams were built before 1900, to supply power for water-driven mills or small hydroelectric stations. Today many dams have not only outlived their purpose; they have also outlived their owners. When such an "orphaned" dam goes neglected and unmaintained, it can pose an active threat to life and property.

Instead of presuming that all existing dams should be repaired, the River Restore program of the Division of Fisheries and Wildlife (DFW) has begun to identify dams that have outlived their purpose and can be safely removed. Inter-agency teams will evaluate safety, cost, and environmental concerns. The teams will consider the aesthetic and recreational values of the man-made ponds and lakes, as well as ways to deal with the contaminated sediments that often collect behind a dam and might be released when it is removed.



RIVER RESTORATIO

Removal of the Billingto Street dam in Plymouth the first coastal dam removal project und DFW's River Restor program, will improv fish passag and restore natural temperature and oxygen level in the river. (Photo: Milon & MacBroom

WHAT SHOULD BE DONE

By State Government

- Improve our ability to monitor water quality statewide to identify the sources of pollution.
- Complete watershed assessments for all 28 watersheds by 2003, and complete watershed plans for all 28 watersheds by 2004.
- Develop and implement programs to reduce pollution from stormwater and other nonpoint sources.
- Complete TMDLs for all watersheds not meeting state water quality standards.
- Restore 3,000 acres of inland and coastal wetlands by 2010.
- Reopen key sections of Massachusetts rivers to a free-flowing condition by breaching or removing dams.

By Local Government

- Develop comprehensive water resource plans that provide long-term solutions to water supply and wastewater treatment needs, while protecting natural water resources.
- Expand efforts to reduce nonpoint source pollution.
- Expand local water conservation and I&I reduction programs.
- Develop "environmental zoning" and other measures, protecting current and future water supplies from development that would affect its quality and quantity.

By Businesses

- Participate in the Corporate Wetlands Restoration Partnership program.
- Maximize water conservation and efficiency in industrial processes, workplaces, and new development projects.

By Citizens

- Join your local stream team, watershed association, or lake association.
- Participate in a local Vernal Pool Day.
- Conserve water by installing low-flow showerheads, faucet aerators, and water-saving devices for toilets; minimize outdoor watering.
- Plant drought-tolerant native plant species.
- Inspect and maintain your septic systems regularly. Upgrade malfunctioning systems, and avoid phosphate detergents and septic system additives.
- Minimize or eliminate the use of lawn and garden chemicals by using integrated pest management (IPM) techniques, including disease- and insect-resistant plants, nontoxic insecticidal soaps or biodegradable insecticides, and organic fertilizers.
- Recycle waste oil by returning it to service stations that offer recycling services or to the store where you bought it. Do not discard used oil with trash or pour it down drains.

4.

PREVENTING POLLUTION

FROM REGULATORY COMPLIANCE

TO

ENVIRONMENTAL STEWARDSHIP

PREVENTING POLLUTION

Preventing pollution begins with setting and enforcing environmental regulations to protect public health and natural resources. Over the past three decades, protective standards and strong enforcement have significantly reduced the amount of pollutants released in Massachusetts. We have seen an 80% reduction in the release of toxic chemicals, the closure of over 100 unlined landfills, a marked increase in recycling, and the creation of a first-in-the-nation privatized hazardous waste cleanup system.

Despite these improvements, communities continue to feel the impacts of numerous diffuse sources of pollution. To address these sources, the environmental agencies are targeting those substances, products, and processes that pose the greatest environmental and public health risks. Government also has a special responsibility to protect the most vulnerable members of society: poor and minority communities, children, and the elderly. EOEA is committed to supporting the growing environmental justice movement in Massachusetts, so that all residents have equal access to a safe and healthy environment regardless of race, income, or culture.

Ultimately, the best way to prevent pollution at the source is to "make the marketplace work for the environment." Each member of society must incorporate a sense of responsible environmental stewardship into everyday life. Businesses must strive to operate in a manner that is cleaner, smarter, and more profitable. Consumers must take responsibility for the environmental consequences of their purchases and investments. Government must take a leading role in encouraging new processes and technologies.

4.

MAKING THE MARKETPLACE WORK FOR THE ENVIRONMENT

Tough enforcement of protective regulations is the backbone of our environmental protection efforts. Regulations keep the cost of polluting high, so polluters pay the costs associated with their pollution. DEP supports its permitting with a comprehensive program of technical and financial assistance, follow-up field visits and monitoring reports to ensure compliance, and, where necessary, enforcement actions and penalties. But even the 16,000 permits that DEP issues each year control only a part of the pollution that is generated in Massachusetts. Effective environmental protection efforts must be broader than end-of-the-pipe pollution controls; it must prevent pollution at the source.

What would happen if people knew that childrens' light-up sneakers contained toxic amounts of mercury, and if the cost of those sneakers included the cost of their safe disposal? What would happen if the cost of gasoline included the costs associated with the air pollution generated by cars? What would happen if the cost of fertilizers included the costs associated with water pollution from farm and yard runoff? One thing is clear: the costs associated with environmental regulations would pale in comparison.

The free-market economy works well when consumers have useful and accurate information about the quality and cost of products and services. In contrast, the marketplace does not work well when consumers have incomplete information, or when prices do not reflect the full range of costs associated with their manufacture, use, and disposal.

In Massachusetts we are striving to "make the marketplace work for the environment." We are getting useful information out to the public

GREEN PRODUCTS

The market for recycled products is expanding. SelecTech in Taunton, creates floor tiles, planters, and other products out of hard-to-recycle plastics. (Photo: SelecTech, Inc.)

DIAGRAM 4.1:
THE CONCEPT OF INDUSTRIAL ECOLOGY

Source: EOEA

Pollution prevention means examining the entire life cycle of a product, from design and extraction through manufacturing, use, and disposal. We can create thrifty closed-loop systems that recycle all wastes, as natural ecosystems do.

about the environmental risks and costs associated with products, giving people what they need to be responsible environmental consumers. And we are exposing the hidden costs associated with pollution – from the medical costs of treating asthma to the damages inflicted on property and natural resources – by focusing increasing attention on the entire life cycle of products, and not just on the pollutants emitted from smokestacks and pipes.

Pollution prevention means examining the entire lifecycle of a product, from design and the extraction of raw materials through all the intervening steps: processing and manufacturing it in factories, selling it in stores, moving it from one place to another, and using it and disposing of it at work or at home. Just as the ecosystems of natural communities operate as thrifty closed-loop systems, recycling wastes like carbon dioxide or dead plant and animal matter back into useful energy or nutrients, this concept of "industrial ecology" should guide product manufacturing and consumption.

At each step in a product's lifecycle, there may be opportunities to use smaller amounts of harmful materials or more benign substitutes, or to sell or reuse waste byproducts as valuable commodities. If pollution prevention is successful, the use of non-renewable resources and toxic chemicals will become increasingly cost-prohibitive, and clean, efficient industries and "green" products will enjoy a competitive advantage in the free market economy.

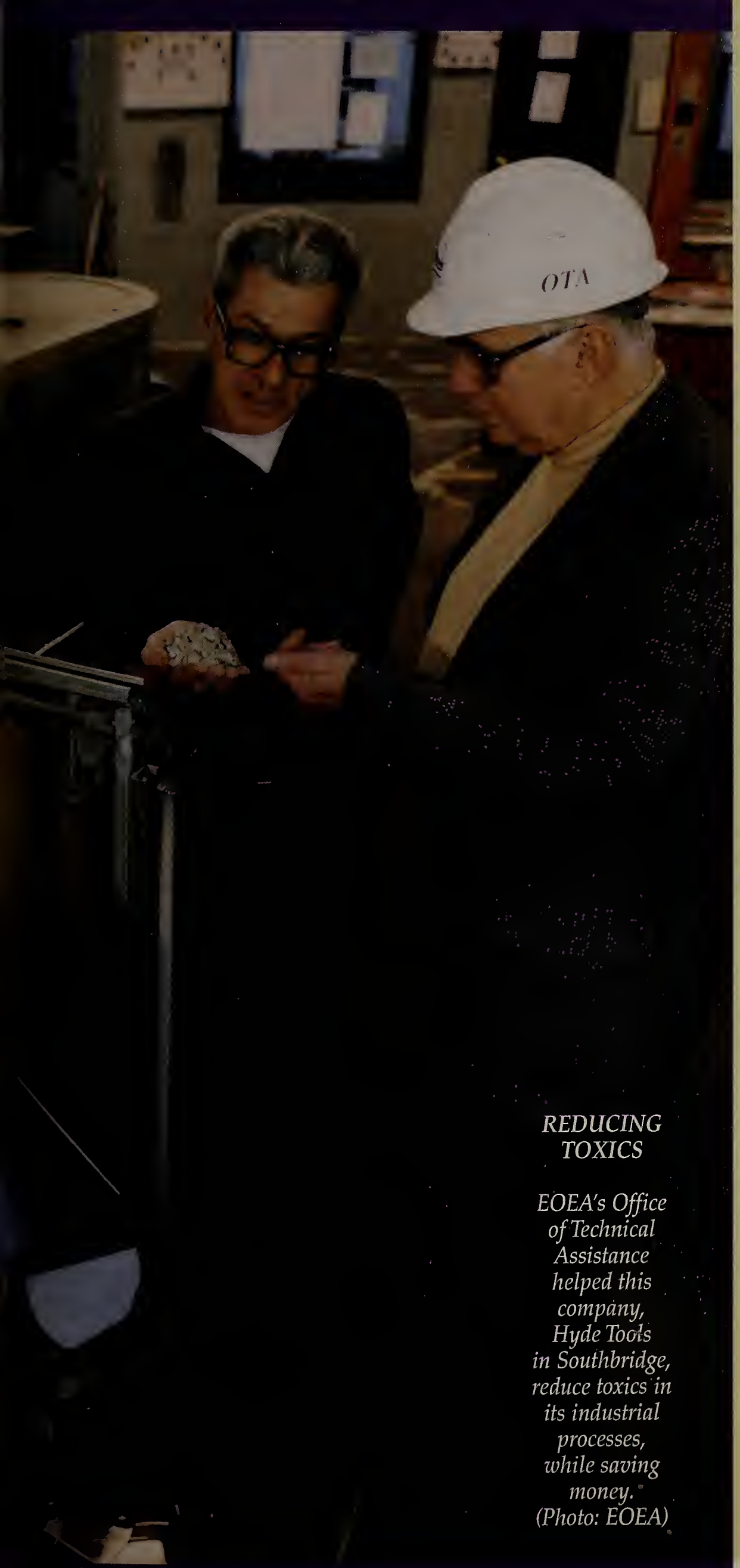
4.

FOSTERING ENVIRONMENTAL STEWARDSHIP

This shift in the marketplace has already started in Massachusetts. Increasingly, businesses and government agencies are trying to "do the right thing" environmentally. The state has a special obligation to recognize, reward, and invest in this shift towards environmental stewardship, creatively and aggressively, to sustain our environmental protection and resource conservation efforts.

"Green" products, such as recycled paper, plastic lumber, mercury-free lamps, non-toxic cleaners, organically grown products, and low-emission vehicles are becoming more attractive and affordable. Businesses with strong environmental performance records are recognizing significant cost savings and consumer support, giving them competitive market advantages.

Massachusetts state agencies are using their purchasing power to support markets for recycled products, and are using state facilities to demonstrate the performance of new environmental technologies.



REDUCING TOXICS

EOEA's Office of Technical Assistance helped this company, Hyde Tools in Southbridge, reduce toxics in its industrial processes, while saving money. (Photo: EOEA)

REDUCING THE USE OF TOXICS

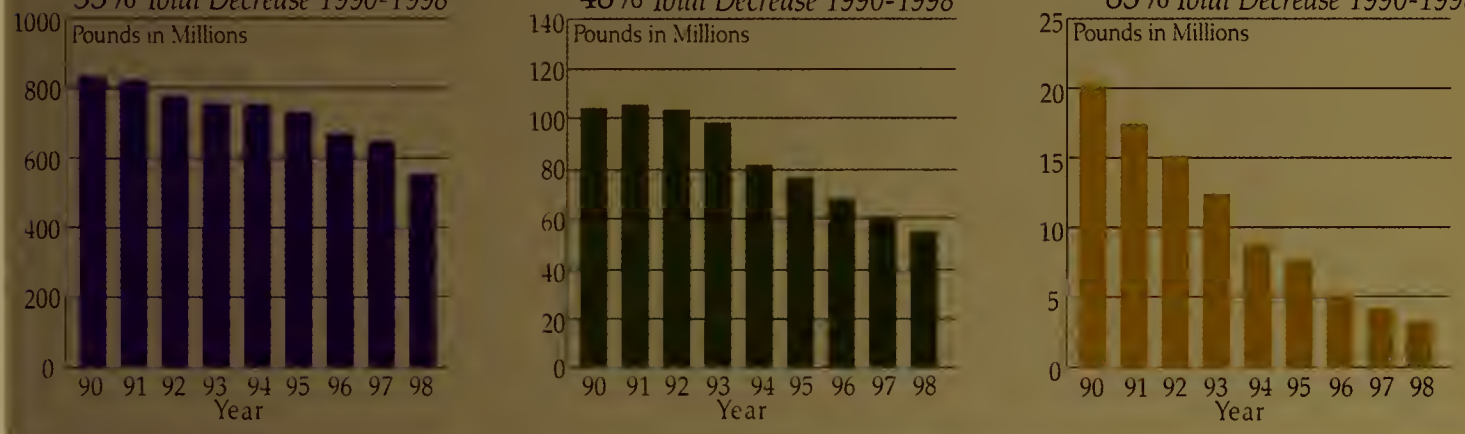
The best way to prevent dangerous releases of hazardous materials is to reduce the overall use of those materials at the source. The 1989 passage of the state's Toxics Use Reduction Act (TURA) defined a new model for preventing pollution, and it created a new standard for industry/government collaboration. TURA embodies the core principles of pollution prevention and toxics use reduction: it is better and more efficient to reduce pollution at its source than to control releases into the environment.

Modern industrial processes rely on a wide range of chemicals that can harm human health. Waste oils, cleaning solvents, sludges laden with heavy metals, and paints comprise the bulk of the approximately 190,000 tons of hazardous waste generated each year by Massachusetts businesses. All sectors of the economy are involved: electronics and chemical manufacturing; drycleaners, photolabs, and auto repair shops; and hospitals, universities, and government agencies.

Under TURA, each manufacturer reports publicly on its use, generation, and releases of toxic materials. Each company also must undertake a biennial planning process in which it identifies and evaluates cost-effective methods to reduce the use of toxics at its own facilities. EOEA's Office of Technical Assistance (OTA) and the Toxics

4.

ENVIRONMENTAL INDICATOR 4.1: TOXICS USE, GENERATION, AND EMISSION



Source: DEP

The pollution prevention structure of the 1989 Toxics Use Reduction Act (TURA), which requires companies to report publicly on toxics use and plan actively for their reduction, has dramatically reduced the use, generation, and release of toxics.

Use Reduction Institute at the University of Massachusetts fund a program of research and technical assistance to companies, supported by $3.6 million in annual user fees collected from 520 large toxics users.

TURA also helps the neighbors of facilities that use toxic materials. The data that are collected on the use and release of toxic materials at these facilities provide citizens with necessary information about potential risks to their health and safety.

The passage of TURA has spurred companies to reformulate products, redesign production processes, substitute non-toxic chemicals, and find new uses for recycled wastes. Since 1990, total use of toxic chemicals by Massachusetts businesses has decreased by 33% (277 million pounds), the generation of toxic wastes has decreased by 48% (50 million pounds), and permitted emissions of toxics into the environment have decreased by 83% (17 million pounds). Massachusetts has consistently ranked among the top five states nationally. To provide one comparison, Massachusetts companies use, on average, less than one-half the amount of toxics as those in Connecticut. We are approaching TURA's goal of reducing total toxics generation 50% by the end of 2000.

Toxics reduction also makes good economic sense. An independent cost-benefit analysis of TURA showed that industries saved more than $91 million in the first four years of the program — $14 million more than the total costs associated with TURA and its implementation. In 1999, the Ford Foundation chose the TURA Program as one of ten winners in its "Innovation in American Government" award.

When a facility does generate toxic wastes, federal and state laws require a system of "cradle to grave" reporting of hazardous materials use. All hazardous materials generators in Massachusetts must register all shipments with the state, disclosing the type and quantity of waste generated and its ultimate destination. Since 1986, the number of large-quantity generators in the state has decreased by more than half, from 1,108 to 475—a clear indication that businesses are voluntarily reducing their use of hazardous materials of all kinds.

The success of the TURA program suggests applying this approach to cover other potential pollution sources, as well as giving manufacturers credits for source reduction in other areas, such as water and energy conservation and solid waste reduction. In addition, we need to focus our efforts on the most highly hazardous chemicals—especially those that persist in the environment long after their release.

ENVIRONMENTALLY SOUND POLICY IS GOOD BUSINESS FOR CHICOPEE COMPANY

A Chicopee metal plating company seeking cost reductions has found that environmentally sound and fiscally prudent practices can produce economic rewards.

Poly-Plating, Inc., uses a chemical bath process to bond nickel onto machine parts for aerospace, aviation, and other applications. The company faced rising costs for water use, wastewater discharge, process monitoring, and raw materials, according to Tony D'Amato, then the company's vice president.

When efforts to use off-the-shelf products to recycle toxic substances in the plating process proved fruitless, company president Ed Ondrick decided to develop a new process.

Workers designed and built equipment to recover toxic substances from the plating rinse water and to recover the mineral acids from the plating solution. The same water could then be reused over and over again. "It took a lot of work and a lot of expense. No one had ever attempted anything like this in the metal finishing industry," D'Amato said.

As a result, Poly-Plating cut its disposal costs by 98%, its acid purchases by 99%, and its water use from 78,000 gallons per day (gpd) to just 880 gpd. The effort also paid off with patents for Poly-Plating and an award from the Toxic Use Reduction Act (TURA) program, run jointly by the Executive Office of Environmental Affairs (EOEA) and the University of Massachusetts at Lowell.

When officials from the federal Environmental Protection Agency (EPA) looked at the new process, they made a suggestion. "They told us that a lot of other platers would like it, so we started a second company," D'Amato said.

Thus was born Zero Discharge Technologies, Inc., of which D'Amato is now the vice president. The company manufactures and markets the equipment and processes invented at Poly-Plating, and it has branched out into recovery of toxics from baths used in other plating processes and other applications.

4.

COMPOSTING

The composting of organic matter eliminates wastes from landfills and provides an excellent source of natural fertilizer, reducing reliance on chemical pesticides and fertilizers. (Photo: EOEA)

LESS TRASH, CLEANER TRASH: MANAGING THE WASTE STREAM

Each year, the average person in Massachusetts generates 1.3 tons of trash: containers and packaging made of glass, metal, plastic, and cardboard; newspapers, magazines, and other papers; food and yard wastes; and all the other kinds of trash that wind up in wastebaskets and dumpsters at home and at work. This figure does not include the 0.7 tons of industrial solid waste (technically classified as "non-municipal solid waste," this is chiefly construction and demolition debris) that is also generated annually for each person.

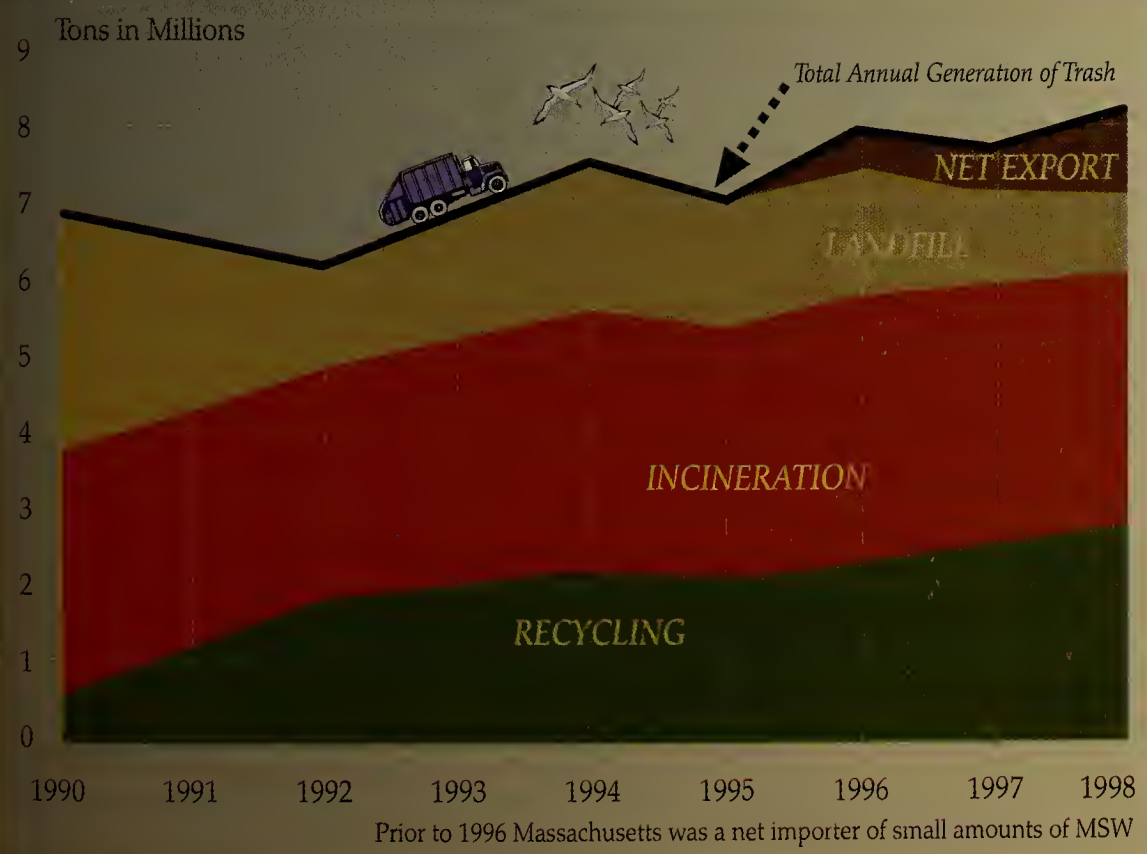
In 1990 Massachusetts adopted a statewide Solid Waste Master Plan that set out to transform the way citizens and businesses generate and dispose of solid wastes. The Master Plan called for closing polluting landfills, dramatically increasing the recycling rate, reducing waste generation, and dealing more effectively with hazardous household products.

We have made significant progress toward the Master Plan's goals. Through 1998, the recycling of trash generated by households and businesses had risen from 10% to 36%, a total of 2.8 million tons. Of industrial wastes, mostly

construction and demolition debris, 70% (3.1 million tons) was recycled at 43 waste processing facilities. In all, 5.9 million tons of solid waste, 48% of the statewide total, were recycled. These recycling figures put Massachusetts among the top ten of all states.

Recycling does not just happen. It requires an infrastructure of containers, vehicles, and facilities to collect and sort the wastes, businesses to transform those wastes into usable products, and enough market demand for the products to keep those businesses profitable and growing. All three of these forces are at work in Massachusetts.

ENVIRONMENTAL INDICATOR 4.2: TRASH GENERATION, DISPOSAL, AND RECYCLING



Prior to 1996 Massachusetts was a net importer of small amounts of MSW

Source: DEP

We have made significant progress toward the goals of the 1990 Solid Waste Master Plan, which aimed at increasing recycling and closing polluting landfills. The recycling rate for trash (municipal solid waste) has increased from 10% to 36%.

Under the Bottle Bill, signed into law in 1983, each year 1.5 billion containers are recycled back into useful products, keeping them out of landfills and off roadsides. The five cent redemption system results in the return of 70% to 80% of all Bottle Bill containers, compared with a recycling rate of about 34% for containers not covered by the law.

Unclaimed bottle deposits are used to fund recycling efforts. Since 1990 the state has invested $125 million dollars in direct grants from the Bottle Bill fund to cities and towns to pay for household recycling and composting bins, larger containers for drop-off centers, and recycling trucks. Today 85% of Massachusetts citizens have access to recycling through local curbside or drop-off programs.

Public and private collection companies sell recyclables to businesses that can turn them into usable goods. To cite just one example out of hundreds, SelecTech, Inc., of Taunton, makes planters, landscape timbers, floor tiles, and speed bumps out of recycled plastics. Leaves and other yard wastes are composted, using natural processes to return nutrients to the soil. Bricks and concrete are pulverized for backfill on new construction sites.

ENVIRONMENTAL INDICATOR 4.3: GENERATION, DISPOSAL, AND RECYCLING OF INDUSTRIAL DEBRIS

Source: DEP

70% of industrial wastes, mostly construction and demolition debris, are recycled at 43 processing facilities.

It is currently estimated that 200 recycling manufacturers employ 12,000 people in Massachusetts and contribute $600 million annually to the state's economy — not counting the savings from all the waste that didn't need to be landfilled or incinerated. The state helps support the industry by buying recycled products ($42 million worth in fiscal year 1999) and investing in research at the University of Massachusetts and the Chelsea Center for Recycling and Economic Development.

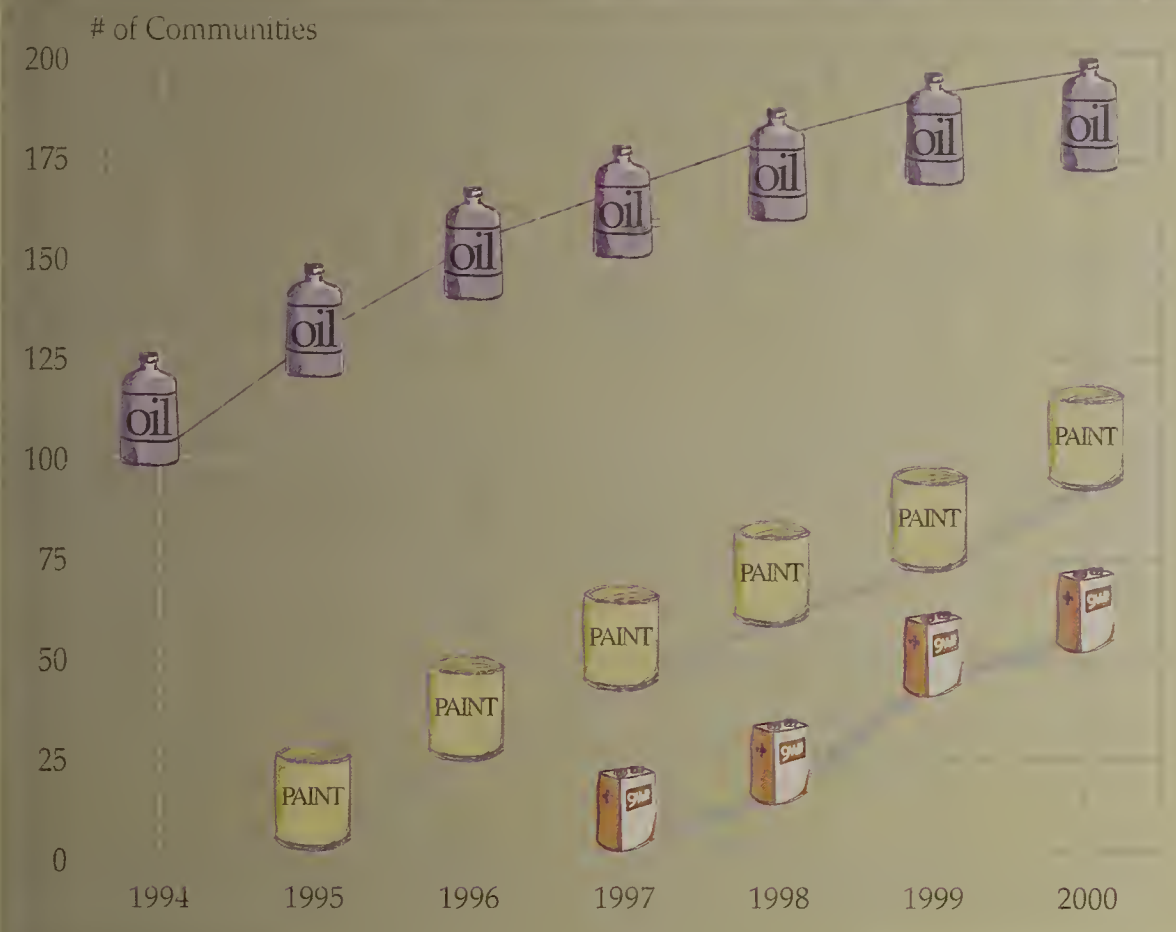
While the volume of recycled waste has been rising, the volume of landfilled waste has been dropping. In 1998 only 18% of all waste was landfilled in the state. Today there are only 19 landfills in the state still accepting waste. By the end of 2000 we will have closed the last of over 100 unlined landfills that were still accepting household trash. Each closed landfill must be capped by an impervious top layer, to prevent rainwater from seeping through the trash to create leachate, water laden with pollutants. Drainpipes capture any leachate that does form. Pipes and flares are installed to vent and burn toxic methane gas, formed by the decomposition of organic materials.

New facilities can then be developed on top of a capped landfill, returning the site to productive use – a prime example of "brownfields" redevelopment (see also Chapter 2). Examples of reclaimed landfill sites include commercial projects, golf courses, and public parks.

The balance of our trash, currently about 25% of all waste, is combusted at seven facilities, all of which generate energy from wastes. The controlled burning of trash in incinerators reduces the volume of trash to be landfilled by 75% or more, and the combustion can be used to power electric generators. But incinerators generate significant emissions, and incinerator ash contains toxic heavy metals that must be carefully disposed of.

As well as reducing the total volume of the waste stream, we need to reduce its toxicity. Many products that we routinely used to throw away — paint, motor oil, antifreeze, batteries, fluorescent lightbulbs — contain hazardous substances that don't break down in a landfill or incinerator, but can pose long-lasting health hazards. In 1997, local programs collected over 7,000 tons of household hazardous waste. Every citizen needs to avoid purchasing hazardous products whenever possible, and to collect and dispose of these materials responsibly.

ENVIRONMENTAL INDICATOR 4.4:
HOUSEHOLD HAZARDOUS WASTE COLLECTIONS



Source: DEP

Many household products contain hazardous substances that pose long-term public health risks. In 1997 local programs collected over 7,000 tons of household hazardous products.

INVESTMENTS IN RECYCLING

Recycling employs 12,000 people in Massachusetts and contributes $600 million annually to the economy. The state has invested $125 million in underwrited bottle deposits since 1990 to build up the local infrastructure to support recycling.

4.

FROM LANDFILL TO PARK

Closing and capping the Gardner Street landfill project in West Roxbury is turning this "brownfields" site into an environmentally sound recreational area. (Photo: Camp Dresser & McKee)

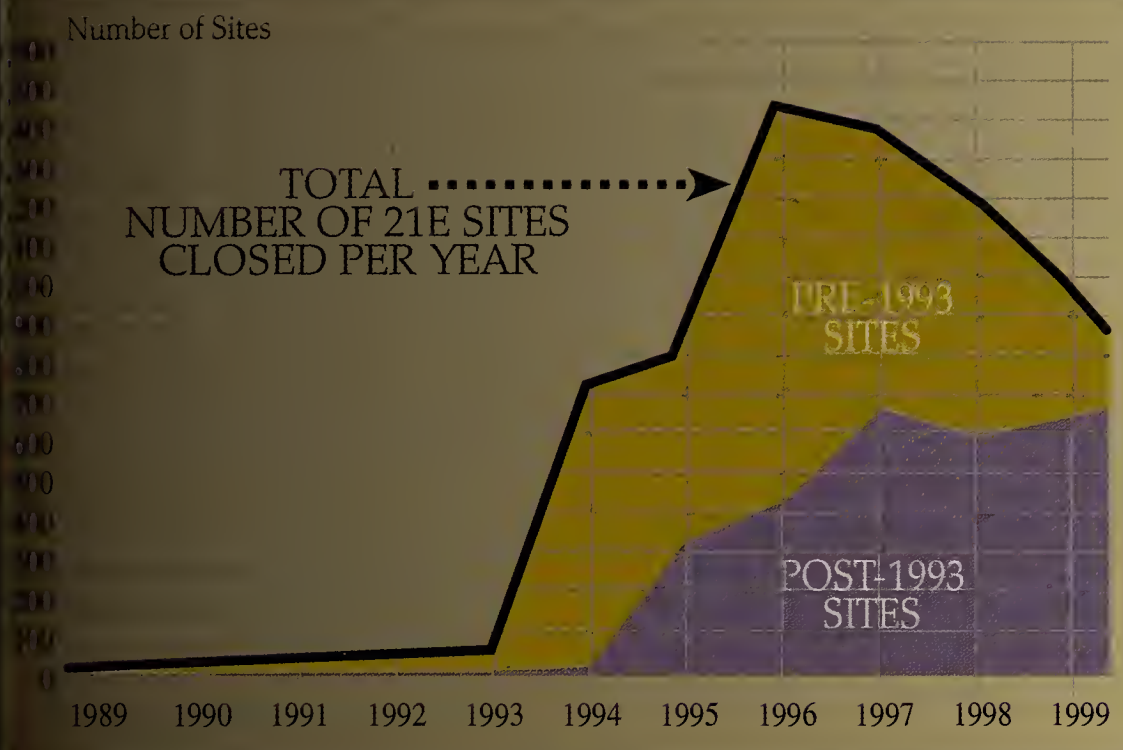
ACCELERATING HAZARDOUS WASTE SITE CLEANUPS

Massachusetts' industrial heritage, although critical to the state's prosperity, has left many problems. Past releases of metals, solvents, PCBs, petroleum products, and other substances have contaminated waters, soils, and wildlife. The 1993 reform and privatization of the state's hazardous waste site cleanup program (governed by Chapter 21E of the Massachusetts General Laws) has caused a dramatic increase in the cleanup of dirty sites, while maintaining tough standards for protecting public health and the environment.

The cleanup of hazardous waste sites is regulated by the federal Comprehensive Emergenc Response Cleanup and Liability Act (commonly known as CERCL or Superfund, because the law created a trust fund to cover costs when the responsible party could nc or would not perform the cleanup and its state-level counterpart, Chapter 21E. These laws were passed in response to events like the contamination of the Love Cana neighborhood in Niagara Falls, New York, by pollutant-laden soil, o the drinking water contamination in Woburn in the 1970s.

There are currently about 6,400 sites in the state's 21E program. Over 70 Massachusetts sites (31 at the Massachusetts Military Reservation on Cape Cod) appear on the federal Superfund list.

ENVIRONMENTAL INDICATOR 4.5: CLEANUPS OF CONTAMINATED SITES



Source: DEP

The number of sites cleaned up annually has increased dramatically since the 1993 reform and privatization of the 21E program.

CERCLA and 21E established broad legal liability, making past and present owners and operators of a site potentially responsible for the entire cost of its cleanup. These laws made investors much more conscious of the condition of the land and buildings they were buying. An assessment of environmental site conditions is now a routine part of every commercial real estate transaction.

The 1993 reform of the 21E program set a national precedent by harnessing the energy and expertise of the private sector to accelerate the pace of cleanups. Clear notification and cleanup standards made the process more certain, while performance-based rules allow flexibility in developing cost-effective solutions.

DEP regulations rank and prioritize site cleanups and allow a variety of solutions, based upon a risk-based approach to human health threats. When there is a potential threat to drinking water supplies, or the proposed reuse involves highly sensitive activities like housing, schools, or parks, then a higher cleanup standard applies. In all but the most serious situations, a state-licensed site professional hired by the property owner prepares and implements the cleanup plan, subject to both random and targeted DEP audits.

This greater reliance on the private sector was designed to allow DEP to concentrate its efforts on the most highly contaminated sites. Currently, DEP directly oversees cleanups at approximately 5% of all sites, as well as all emergency and time-critical responses. Since 1993 DEP has approved over 10,000 preliminary response actions, significantly reducing risks at disposal sites. Private parties currently handle approximately 70% of all sites. The remaining 25% of sites are subject to DEP enforcement because the responsible parties failed to perform response actions.

The 21E reforms responded to widespread frustration with the former system, which was shared by DEP and parties wanting to clean up their properties. The stigma of contamination attached to "brownfields" sites – contaminated former industrial sites in cities and larger towns – was causing investors to favor the development of untouched "greenfields" sites in suburban and rural areas. Thus, environmental laws were unintentionally fostering sprawl development. (Chapter 2 describes the regulatory and financial incentives of the state's new program to encourage the redevelopment of brownfields.)

Since the reforms took effect, the number of cleaned-up sites has risen dramatically: from fewer than 100 per year through 1993 to an average of over 1,000 per year starting in 1994. As the science of remediating spills improves, engineers have developed new methods of pumping and treating contaminated groundwater, and treating, capping, or removing contaminated soils. DEP is now focusing attention on high-priority sites. DEP is also working to tighten licensing standards for site professionals, and it is auditing sites where relatively low levels of contamination have been left in place, subject to legal restrictions on future use of the property.

4

TARGETING COMMUNITIES AT RISK

Across the nation, including in Massachusetts, racial minorities and low-income communities have been saddled with more than their fair share of pollution sources, blight, and public health threats. The growing environmental justice movement in Massachusetts is striving to level the playing field, so that all residents have equal access to a safe and healthy environment, regardless of race, income, or culture. At the federal level, Executive Order 12898, issued by President Clinton, requires all federal agencies to identify and address "disproportionately high and adverse human health or environmental effects" of their actions on minority and low-income communities.

In 1999, the Executive Office of Environmental Affairs (EOEA) created the state's first Environmental Justice Program. Environmental justice issues have become more critical in Massachusetts as the state's racial and ethnic identity becomes more diverse, and as disparities in income and wealth grow larger between different communities and different sectors of the population. EOEA is forging ties with residents and community-based organizations. The program seeks to gather comprehensive baseline data on the distribution of environmental and public health threats, and identify places where those threats affect the most vulnerable members of society: minority and low-income communities, children, and the elderly.

Preliminary research has identified elevated asthma rates, especially among children, as a key environmental and public health concern. Asthma hospitalization rates have risen well above statewide averages in a number of low-income and minority communities in Boston, Lawrence, Holyoke, and other cities. The Department of Public Health (DPH) has confirmed that school nurses and health centers are administering, on average, 28 times more asthma medication to public school children than any other prescription medication. Some researchers have tied the dramatic increase in asthma and other respiratory diseases to air pollutants, particularly the small particulates contained in diesel exhaust. EOEA is working with DPH to develop effective control strategies to reduce urban air pollution.

Residents and community groups have also raised concerns over the potential cumulative impacts of multiple sources of pollution, such as factories, power plants, incinerators, landfills, and hazardous waste sites upon a neighborhood, municipality, or region. Such impacts can be described in different ways:

- Aggregate impacts of a certain kind, ranging from air pollution to traffic, can occur when several facilities or sources affect the same area.
- Synergistic impacts potentially occur if it is shown that different pollutants will affect one another and human health, with harmful results that are different in level or kind from those caused by a substance acting alone.

Although the science of cumulative impacts is an emerging discipline, Massachusetts is committed to answering some of these difficult environmental and public health questions. An initial attempt is an ongoing DEP study of air toxics impacts in the Merrimack Valley. As we learn more about the science of cumulative impacts and try to overcome methodological and other research limitations, public input will continue to inform and direct this research.

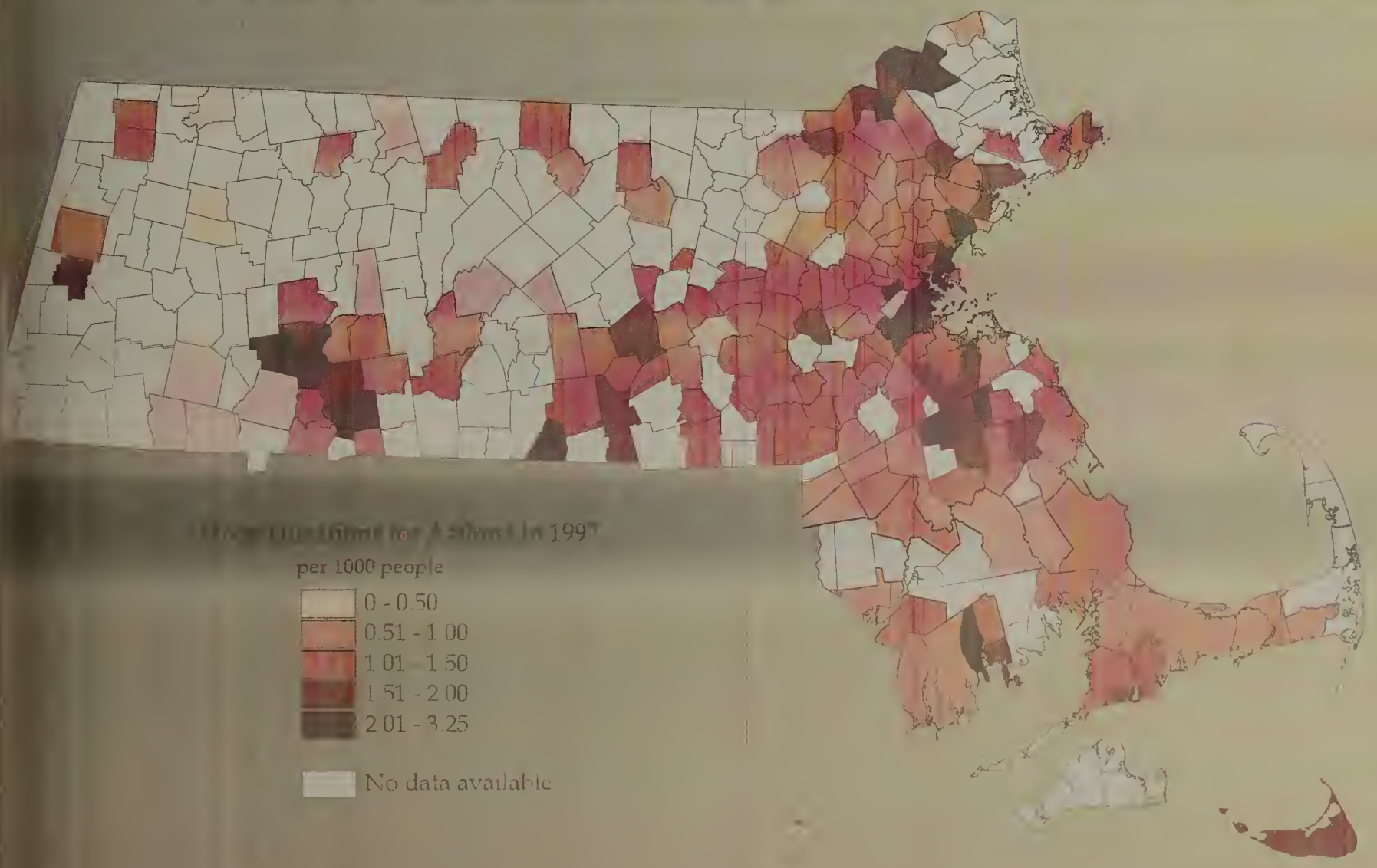
Protecting Children

Because children eat more, breathe more, and have faster rates of metabolism than adults, they are at greater risk from air pollution, toxic chemicals, and other environmental hazards. Children need special attention, yet nationwide there were 2,300 pesticide-related exposures in schools between 1993 and 1996, sending 329 people to medical facilities. A recent report by the U.S. General Accounting Office states that there is still no comprehensive nationwide information on the amount of pesticides in the nation's public schools.

Massachusetts is taking steps to make schools cleaner and greener. The proposed Children's and Family's Protection Act, legislation proposed by MassPIRG and strongly supported by the administration, would prohibit use of the most dangerous pesticides in schools and day care centers. The Act would also promote safer alternatives to pesticides, require notice to parents and teachers before pesticides are used, and establish a publicly accessible registry of pesticide use information.

EOEA's Office of Technical Assistance (OTA), working with DEP and the Department of Public Health, provides on-site technical assistance that shows how schools can eliminate or better manage the use of toxic chemicals and other wastes and improve indoor air quality. OTA is developing a workbook on the subject for school administrators, teachers, and staff.

MAP 4.1
COMMUNITIES WITH ELEVATED ASTHMA RATES



Source: DEH

Asthma hospitalization rates are well above statewide averages in Lawrence and in the city communities in Boston, Lawrence, Lynn, Chelsea and other cities. School nurses and health centers are administering, on average, 23 times more asthma medication (puffers) to school children than any other prescription medication.

4.

MAKING A COMEBACK

The peregrine falcon suffered a tremendous population decline as a result of reproductive failures brought on by pesticide contamination. Following the banning of DDT in 1972 and state efforts to increase population, peregrine falcons have resumed nesting in Massachusetts. This nest is on the Customs House Tower in Boston. (Photo: DFW/Bill Byrne)

MERCURY AND THE RISKS OF BIOACCUMULATION

One of the greatest threats posed by certain toxic chemicals is the process known as "bioaccumulation." Certain chemicals, once ingested, stay in the body. Therefore, the concentration increases as one moves up the food chain. Small fish may carry only small quantities of poison, but the bigger fish that eat them will carry more. Most at risk are the birds and people who eat those fish.

The best-known example of bioaccumulation is the now-banned pesticide DDT. In 1962 Rachel Carson helped launch the modern environmental movement when she published *Silent Spring*, a book describing the impacts of pesticides and other chemicals. Among the animals most affected were large fish-eating birds, like eagles, falcons, ospreys, and pelicans. High DDT levels interfered with egg development, and the number of young birds dropped dangerously low.

The 1972 ban on DDT and similar pesticides has allowed these birds to recover. Peregrine falcons and bald eagles have now resumed breeding in the state. The population of ospreys has increased from fewer than ten pairs in 1970 to 300 pairs in 1996.

The banning of DDT is a notable success story, but today there are many other substances, both artificial and natural, that pose similar risks. One of the most

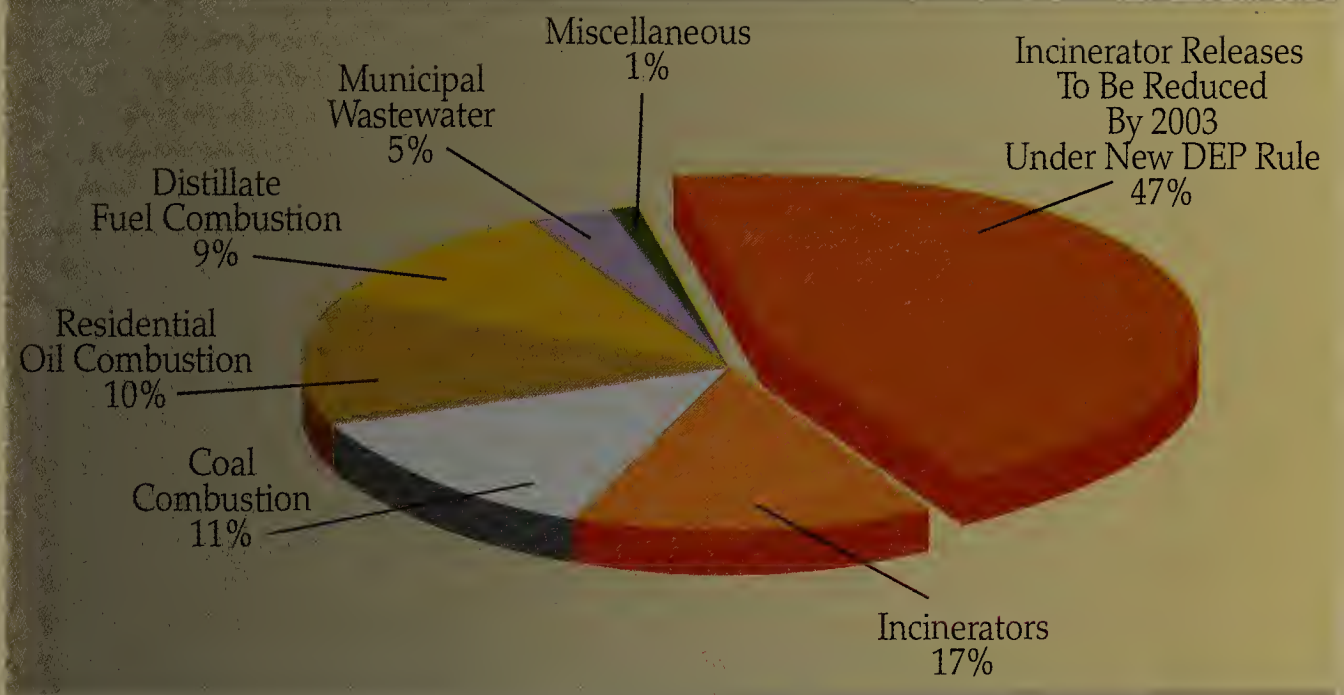
langerous of these is mercury. hat elusive quicksilver metal, vhich skitters across the floor vhen an old-fashioned glass hermometer breaks, is one of he most toxic substances known. Mercury is most dangerous to unborn children and children under six, because it permanently damages their developing nervous systems. Although some background amount of mercury is always present in the air from natural sources, recent studies show that levels are now two to five times higher than they were in pre-industrial times.

Mercury poisoning occurs most often through eating contaminated fish. One-seventieth of a teaspoon of mercury will contaminate all fish tissue in a 20-acre lake. A statewide fish advisory is in place for all pregnant women, recommending that they not eat any native freshwater fish caught in Massachusetts. In addition, the state has issued fish consumption advisories to the general public affecting over 80 water bodies around the state.

Currently municipal trash incinerators are the largest in-state source of mercury. New DEP regulations adopted in 1998 require municipal waste incinerators to install cleanup technology that will remove 85% of the mercury emissions. Once this rule is fully implemented, the largest remaining in-state source will be coal-burning power plants.

About half of the mercury deposited in Massachusetts comes from out-of-state sources, and this proportion is projected to increase as the new incinerator rule goes into effect. Because of the need for concerted regional action, in 1998 Massachusetts and the other New England states and eastern Canadian provinces agreed to virtually eliminate human sources of mercury from the environment. Massachusetts has formed a Mercury Task Force that is developing a coordinated strategy to achieve this goal.

ENVIRONMENTAL INDICATOR 4.6: MASSACHUSETTS SOURCES OF MERCURY



Source: DEP

New DEP regulations will remove 85% of the mercury from municipal waste incinerator emissions – currently the biggest in-state source.

LEADING BY EXAMPLE

Through the state's Strategic Envirotechnology Partnership (STEP) and Clean State programs, Massachusetts has become a national leader in promoting the development and use of new technologies and in ensuring that state government agencies act as good stewards of the environment.

Since the 1994 inception of the STEP program, EOEA and the University of Massachusetts have offered a range of business, technical, and regulatory services to over 140 businesses, helping them move environmentally progressive technologies towards commercial applications. STEP has helped six start-up companies leverage more than $6 million of funding. Private companies are involved in more than 40 technology development projects at UMass, ranging from non-toxic coolants to geothermal heating and cooling.

In January 2000, EOEA and UMass expanded their collaboration, signing an agreement to bring joint government and academic expertise to bear on a wide range of environmental problems: from community preservation to toxics, from watersheds to agriculture to the coastal zone.

In the past, government agencies often did not hold themselves accountable to the same environmental standards as private parties. Executive Order 350 (Clean State), issued in 1993, has changed that situation. All of the approximately 1,000 state-owned facilities have undergone rigorous environmental inspections. State agencies have identified and corrected more than 300 priority violations and nearly 1,800 other violations.

Environment Secretary Bob Durand and UMass President William Bulger at the groundbreaking environmental research and education agreement. (Photo: EOEA)

Completion of all corrective actions is targeted for June 30, 2000. It is estimated that $250 million will have been spent on corrective action.

Plans are underway to incorporate environmental management into the Commonwealth's day-to-day activities (for example, by promoting "green building" strategies, as discussed in Chapter 5).

CLEANER STATE FACILITIES

The Clean State program has ... environmental ... in ... clean ... such as the ... of the ... underground ... or ... tanks, at all of the approximately 1,000 state-owned facilities. (Photo: MassHighway)

WHAT SHOULD BE DONE

By State Government

- Implement DEP efforts to reach the numerous small sources of pollution by replacing permits with performance standards and self-certifications, backed by audits, inspections, and enforcement.
- Focus on source reduction and reducing the toxicity of the wastestream.
- Strengthen the TURA program to promote continued environmental improvement.
- Continue to progress toward Solid Waste Master Plan goals by increasing recycling and reducing waste generation and disposal.
- Develop and implement an Environmental Justice Initiative that considers potential cumulative health and environmental impacts, and seeks to address the needs of urban communities more effectively.
- Develop and implement a comprehensive strategy to eliminate the use and release of mercury and other highly toxic or bioaccumulative chemicals.
- Begin a Clean Schools Initiative to ensure that schools maintain a healthy, safe environment for learning. Assist DPH in developing an environmental management handbook for school personnel. Pass new legislation to reduce or eliminate pesticide use in and around schools.
- Build upon the success of the Clean State Initiative to promote state agency environmental management systems and enhance state purchase of green technologies and products.

By Local Governments

- Increase commercial, institutional, multi-family and municipal recycling, and pickup of hazardous household products.
- Reduce use of toxic chemicals, particularly in schools.
- Buy recycled products.

By Business

- Participate in a Product Stewardship Challenge that reduces the environmental and health impacts of manufactured products.
- Adopt environmental management systems.

By Citizens

- Get active in community and workplace recycling programs. Purchase products made with recycled materials.
- Set up a backyard compost bin to turn yard waste and kitchen scraps into rich soil for gardens and landscaping.
- Buy less toxic or non-toxic alternatives to cleaners, solvents, drain openers, oil-based paints and stains, paint strippers, and automobile antifreeze.
- Never toss hazardous household products in the trash or pour them down the drain. Bring them to community collection centers.
- Buy household products that don't contain mercury (digital thermometers, thermostats, and blood pressure cuffs). Recycle batteries, fluorescent bulbs, and other mercury-containing products (click on DEP web page to find out where to drop off).

5.

AIR POLLUTION AND CLIMATE CHANGE

THE STATE OF OUR AIR

The changes humans are making to the
atmosphere are like an enormous and
unpredictable chemistry experiment.
The burning of fossil fuels – oil, natural gas, and coal
– to power machines, vehicles, and buildings releases
many harmful by-products.
Each adult breathes over 3,000 gallons
of air every day, so even small concentrations
of pollutants can concentrate rapidly in the body. The
long-term buildup of carbon dioxide
and other greenhouse gases
threatens to change the global climate,
putting ecosystems,
farms, forests, and societies at risk.

Massachusetts has long been a leader in
setting aggressive standards that reduce
air pollution in the most cost-effective manner, while
sustaining strong economic growth. Emissions of all
the criteria pollutants
identified in the Clean Air Act
have fallen significantly since 1990.
The number of unhealthy days,
as measured by the one-hour ozone standard, has
dropped from an average of 24 per year in the early
1980s to just 2 per year in recent years.

In the long run, averting global climate change
will require us to reduce the dependence
on fossil fuels through effective conservation
measures in industry, cleaner vehicles,
energy-efficient "green buildings,"
and greater use of solar power
and other renewable energy sources.

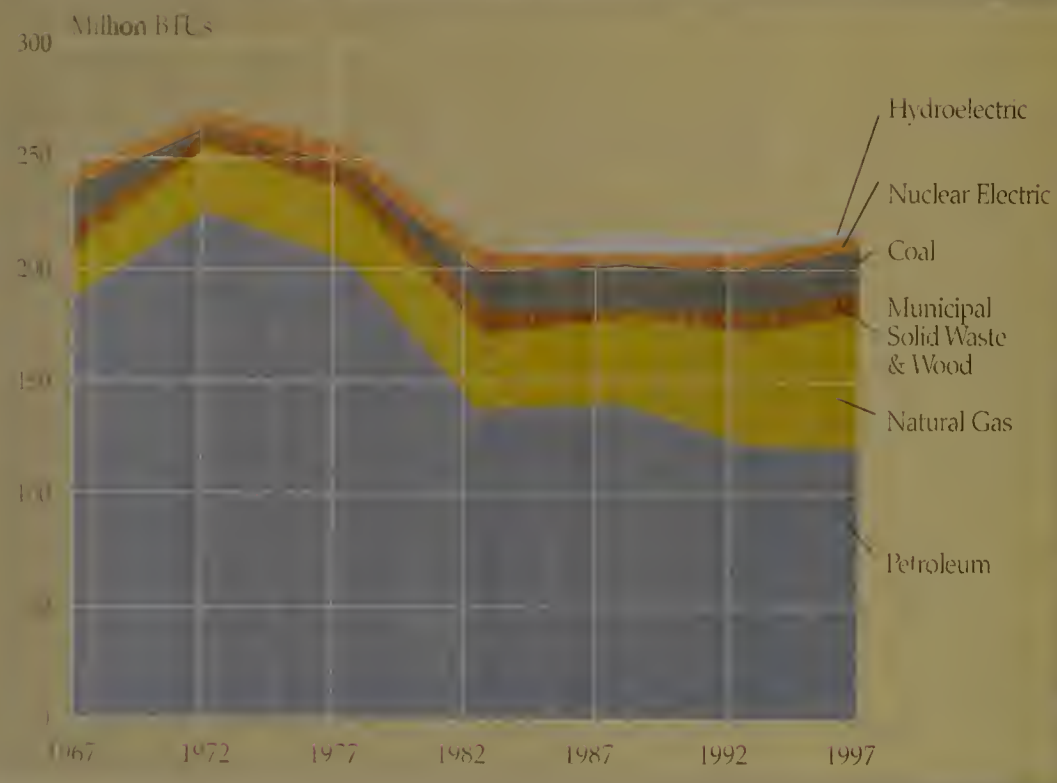
5.

POLLUTION SOURCES AND FUEL USE

Through the use of stringent standards and market-based incentives, since 1990 Massachusetts has significantly reduced emissions of all the "criteria pollutants" regulated under the federal Clean Air Act: nitrogen oxide (NOx), volatile organic compounds (VOCs), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead, and sooty particulates (PM).

This chapter concentrates on three air quality problems: smog, acid rain, and the greenhouse gases that cause global climate change. Massachusetts has not yet complied with the federal standards for low-level ozone, or smog, which is formed from NOx and VOCs (although there have been no violations in eastern Massachusetts within the last three years). Although Massachusetts complies with the direct federal standards for the acid rain precursors, SO_2 and NO_2, we still face significant problems with acid rain, in part because of pollution blown downwind from Midwestern utilities and industries. Finally, although carbon dioxide (CO_2) and other

ENVIRONMENTAL INDICATOR 5.1: TRENDS IN ENERGY USE PER PERSON SINCE 1967



Source: U.S. Energy Information Administration (EIA) 1997 State Energy Data Report

Since a dip in the late 1970s and early 1980s, per capita energy consumption is rising again toward the levels that existed before the 1973 oil crisis.

5.

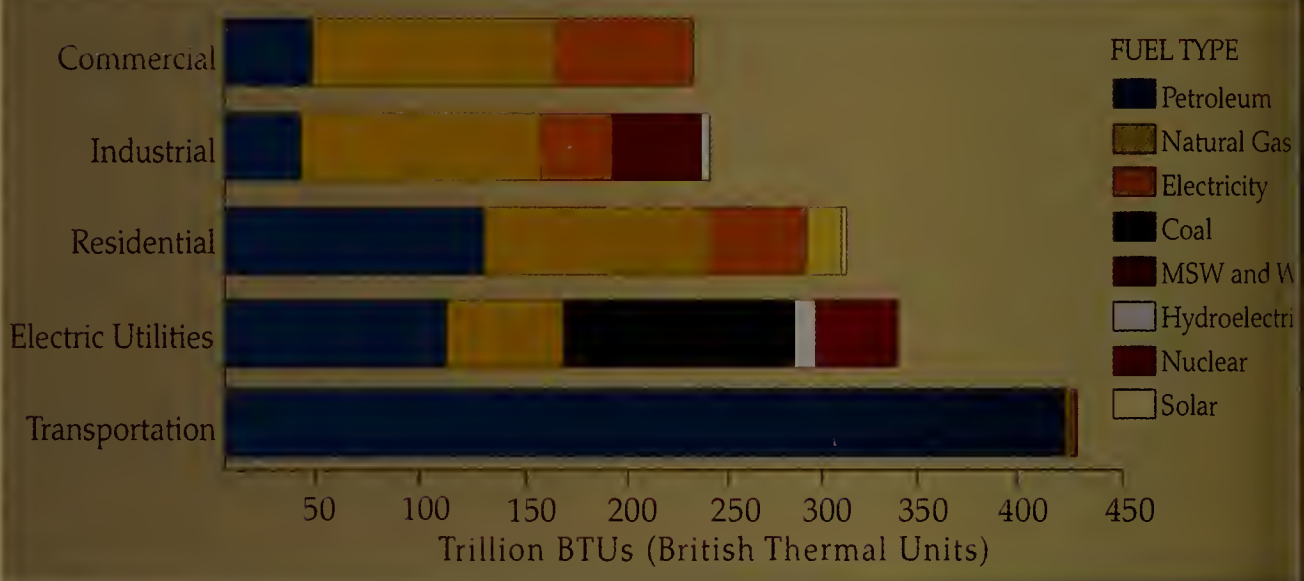
greenhouse gases are not yet the subject of regulation, it is important to begin monitoring and reducing greenhouse gas emissions.

(In addition to these issues, see Chapter 4 for discussions of incinerators and air-borne mercury. There is also increasing concern about the health risks of very fine sooty particulates. New federal standards have been held up in court, but Massachusetts has begun an aggressive statewide monitoring program.)

Because smog, acid rain, greenhouse gases, and other pollutants travel widely in the atmosphere, Massachusetts is not completely in control of its own destiny. The air one breathes today may have traveled from the Great Lakes since yesterday; substances released into our air may affect the environment in Maine, Canada, and Europe. But Massachusetts government, industries, and citizens, working cooperatively with other northeastern states and the EPA, can aggressively reduce pollutants and greenhouse gases, developing new strategies and technologies that will improve conditions here and could serve as models for other states.

To design effective air quality policies, one must understand both the problems caused by different kinds of fuels, and which fuels are consumed by which end-users. In Massachusetts, as in the United States generally, we currently rely upon three primary energy sources: oil (petroleum), natural gas, and coal. Oil derivatives, including gasoline and diesel fuel, account for about two-thirds of all energy consumption in Massachusetts. Natural gas use, which has been increasing recently, now accounts for about 20%, while coal use has fallen to about 10%. Nuclear, hydroelectric, solar power, and all other sources account for less than 2% of the total.

ENVIRONMENTAL INDICATOR 5.2: FUEL CONSUMPTION OF DIFFERENT END-USERS

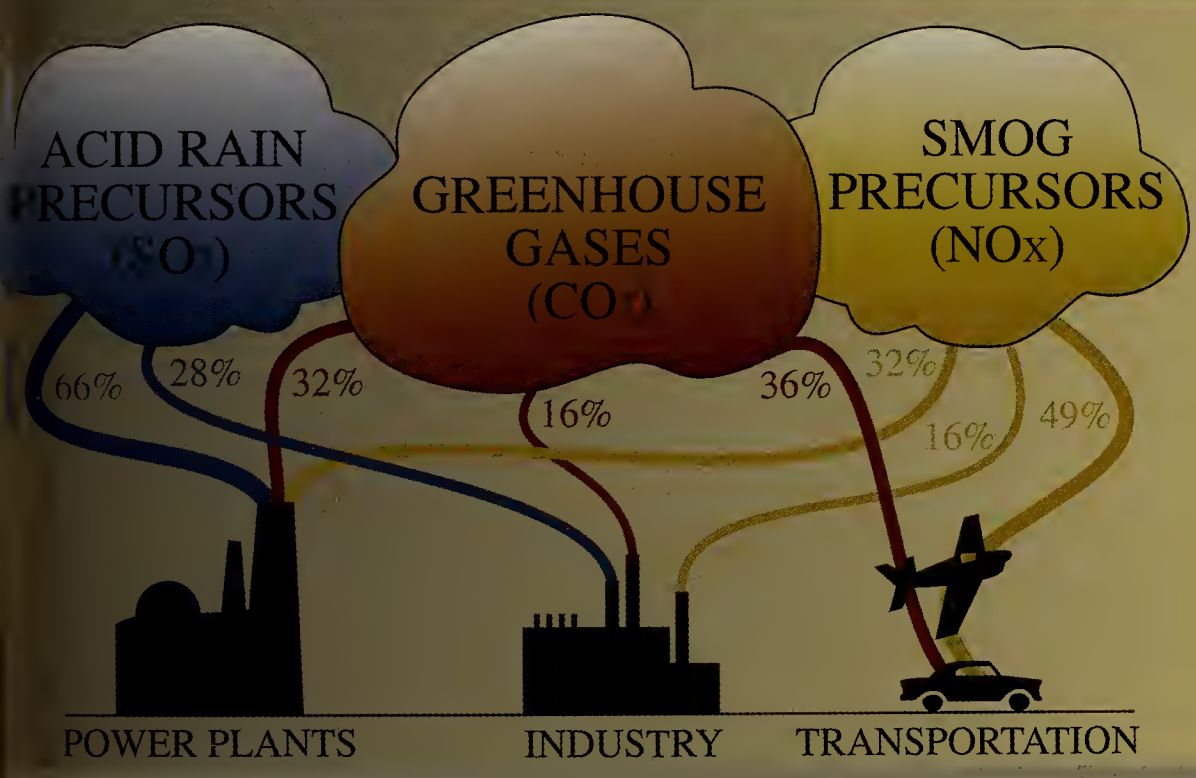


Source: EIA, State Energy Data Report

Different economic sectors rely on different fuel types. Transportation depends almost entirely on gasoline and diesel fuel. Power plants are the only sector to consume substantial amounts of coal (though the trend for coal is down, and for cleaner natural gas is up).

Since a dip in the late 1970s and early 1980s, per-capita energy consumption has risen again toward the levels that existed before the 1973 oil crisis. It took more than 200 million years to form all the oil beneath the earth's surface. It has taken only 200 years to consume half of that endowment. At current global rates, remaining sources of conventional oil will be exhausted in another 40 years.

IAGRAM 5.1: MASSACHUSETTS SOURCES OF ACID RAIN, REENHOUSE GASES, AND SMOG



Source: EOEA, DEP

ower plants produce 66% of all SO_2, the primary acid rain precursor.
ransportation sources produce the largest share of the smog precursor NOx
9%) and CO_2, the primary greenhouse gas (36%).

Different sectors of the economy rely on very different fuel types. The largest end-user, transportation (cars, trucks, buses, trains, and airplanes), depends almost entirely on gasoline and diesel fuel, both petroleum products. The second biggest end-user, power plants, is the only sector to consume substantial amounts of coal (although the recent trend for coal is down, and for natural gas is up). Behind these sectors come commercial and industrial uses, which rely most heavily on natural gas, and residential heating, which relies more heavily on oil.

Fossil fuels emit smog precursors, sooty particulates, and CO_2, the principal cause of the greenhouse effect. Diesel fuel and coal are the most polluting fuels in these respects; natural gas is the cleanest; while gasoline and heating oils are somewhere in the middle. Coal also gives off a high level of the acid rain precursors, SO_2 and NO_2, and it contains toxic mercury.

Diagram 5.1 summarizes this analysis. Power plants produce 66% of all SO_2, the primary acid rain precursor, and 33% of the smog precursor NOx and of CO_2, the primary greenhouse gas. Cars, trucks, and other transportation sources produce the largest share of NOx (49%) and CO_2 (36%). The remaining emissions come from a mixture of industrial sources, home and office heating, and off-road construction machinery and other engines.

5.

SMOGGY DAYS

Smog occurs when NOx and VOCs interact in the presence of sunlight in the lower atmosphere, forming high levels of ozone, a form of oxygen molecule that irritates lung tissues and hampers breathing. Smog is particularly dangerous for children, the elderly, and anyone with asthma or other lung disease. Approximately 750,000 people in Massachusetts – one out of every eight citizens – suffer from asthma or other cardio-respiratory ailments that make them especially vulnerable to smog and other forms of air pollution.

Smog is created by a wide range of sources. More than 40% of the precursors come from cars, trucks, and other vehicles. About 30% comes from power plants, and the balance comes from a diverse mix of construction equipment, factories, and homes. Although VOC levels have declined in recent years, NOx levels are coming down more slowly, and are predicted to start rising again by 2005 unless we take further steps.

Smog is bad, but high-level ozone, 30 to 60 miles up in the stratosphere, protects all living creatures by filtering out harmful ultraviolet rays from the sun. In 1987 the United States joined with other nations to phase out chemicals used in aerosol cans and air-conditioners that were damaging the upper ozone layer over the north and south poles. All production of these chemicals should end by 2005, although it may take decades for natural processes to repair the effects of past releases.

CHOKING ON TRAFFIC

Tailpipe emissions from cars, trucks, and buses account for more than 40% of the smog-causing pollution in Massachusetts. (Photo: EOEA)

ACID RAIN

"Acid rain" forms when sulfur dioxide (SO_2) and NOx mix with water vapor in the clouds, to form sulfuric and nitric acids. The SO_2 in Massachusetts is produced mostly by oil and coal-burning power plants, some in-state and some in upwind Midwestern states. In addition to forming acid rain, the particulates themselves aggravate asthma, bronchitis, and other lung diseases.

Acid rain has damaged forests; in the Adirondacks and the Great Smokey Mountains, large areas of conifers are dead or dying. Acid rain also destroys our history by corroding metals and eating stone; many public buildings and statues show its effects.

When acid rain falls into lakes and streams where the underlying soil has a limited ability to neutralize acids (this is called its "buffering" capacity), the acidity of the water increases, harming or killing plant and animal life. All surface waters in Massachusetts have been affected to some extent by acid rain; in the Berkshires and the Merrimack Valley, there are no fish at all in many of the smaller ponds.

ENVIRONMENTAL INDICATOR 5.3: PROGRESS TOWARD AIR POLLUTION GOALS

POLLUTANT	PROBLEMS CAUSED	TREND SINCE 1990
Nitrogen Oxide (NOx)	Smog — respiratory problems	Down 27%
Volatile Organic Compounds (VOCs)	Smog	Down 26%
Carbon Monoxide (CO)	Affects heart, mental functions	Down 47%
Sulpher Dioxide (SO_2)	Acid rain — damage to forests, freshwater ecosystems, structures	Down 41%
Nitrogen Dioxide (NO_2)	Smog, acid rain	Down 19%
Particulate Matter (PM-10)	Respiratory problems	Down 15%
Lead (Pb)	Brain, liver damage	Down to nearly undetectable levels

Source: DEP

Since 1990 there have been significant reductions in all of the criteria air pollutants identified under the federal Clean Air Act.

5.

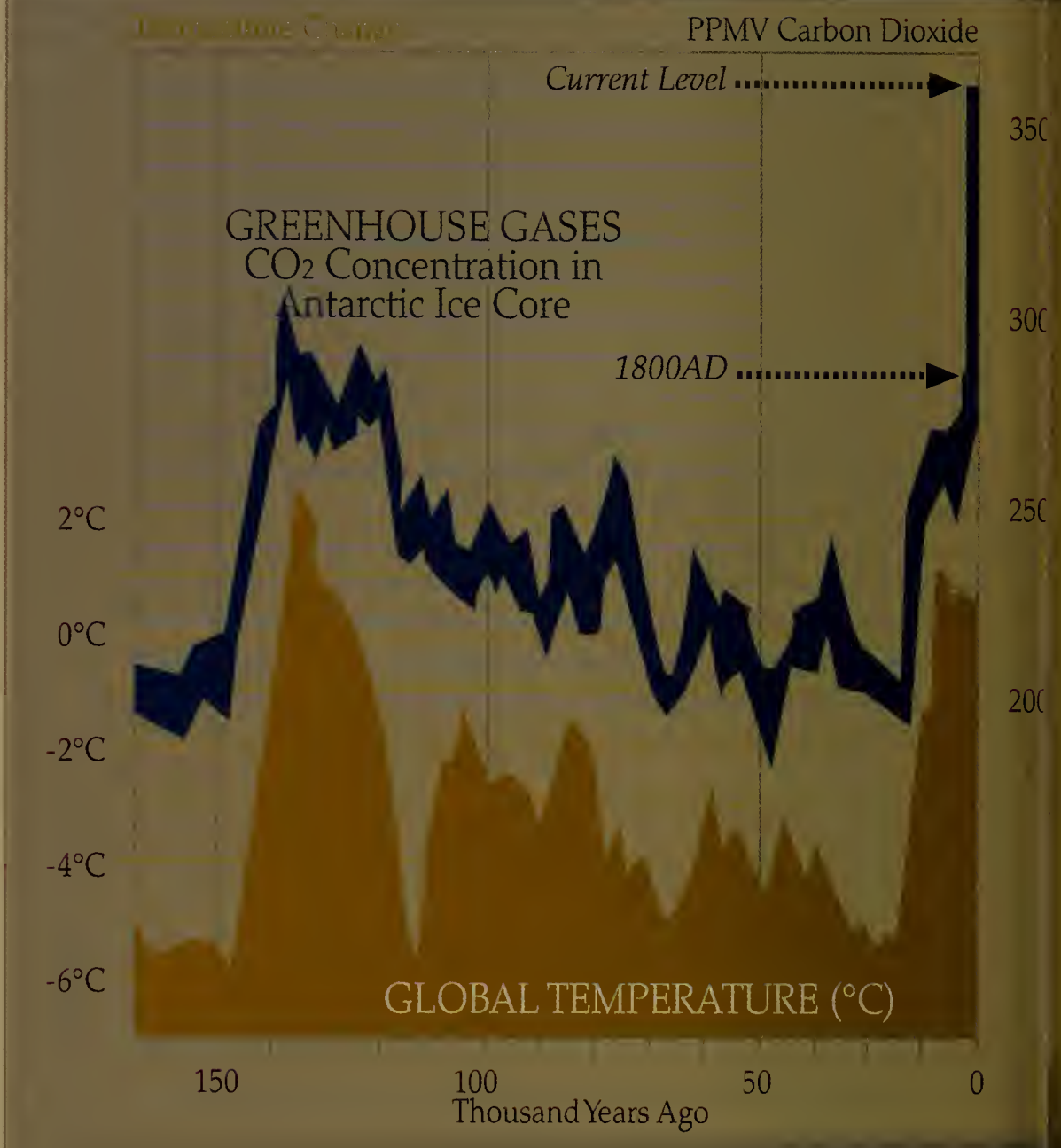
CLIMATE CHANGE

Through the greenhouse effect, the earth maintains a stable temperature that supports humans and other living creatures. Carbon dioxide (CO_2), methane, and other gases in the atmosphere act like glass in a greenhouse, trapping solar energy that rebounds from the earth's surface and preventing it from radiating back out into space.

Since the start of the industrial era, however, the burning of oil, coal, and natural gas for energy has significantly increased the level of greenhouse gases. The clear-cutting of forests for timbering and farming also accelerates the release of greenhouse gases, as fallen trees decompose. Since 1900, average global temperatures have increased 1 degree F. Evidence of the warming trend ranges from retreating glaciers to the fact that the 1990s was the warmest decade in the past six centuries.

The current scientific consensus is that the warming trend is real, and that some if not all of that warming has been caused by the release of greenhouse gases due to human activities. Most scientists also agree that if current trends continue, global temperatures in the next century may increase a further 2 to 6.5 degrees F. These conclusions have been supported by the federal Office of Science and Technology Policy, and the Intergovernmental Panel on Climate Change, established by the World Meteorological Organization and the United Nations Environment Program.

ENVIRONMENTAL INDICATOR 5.4: INCREASES IN GREENHOUSE GASES AND GLOBAL TEMPERATURES



Source: Office of Science and Technology Policy (OST) Climate Change: State of Knowled

The current scientific consensus is that the global warming trend is real, and that some if not most of the warming has been caused by increases of greenhouse gases, due to human activities.

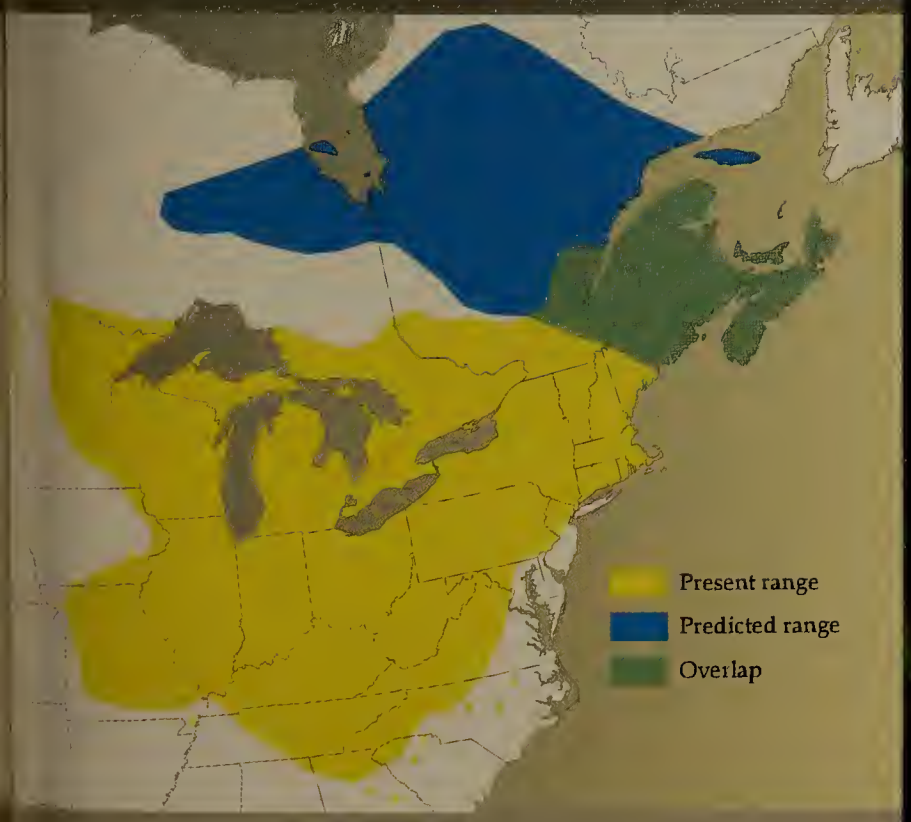
This rapid warming could seriously disrupt climate and rainfall patterns worldwide, with serious and costly consequences. As the Arctic and Antarctic ice caps melt, sea levels would rise. The Massachusetts Coastal Zone Management (MCZM) Office has determined that a 3 to 5 degree global temperature increase would raise sea levels and flood approximately two-thirds of the coastal wetlands in the northeastern United States. The change would permanently cover large areas of the Boston region, Cape Cod, the Islands, and other coastal communities, and it would expose many more people to the dangers of coastal storm surges.

Global warming would also affect the range and viability of many plant and animal species. Changing patterns of rainfall, droughts, and intense heat will affect ecosystems, and the farms, forests, fisheries, and societies that depend upon them.

Greenhouse gas emissions are not currently regulated under the federal Clean Air Act. However, in 1996 representatives from the international community met in Kyoto, Japan, where they negotiated and signed the first international agreement to address global warming. Its central goal is a 10% worldwide reduction in greenhouse gases, compared with 1990 levels, by the year 2010.

In Massachusetts, EOEA is working with other agencies and stakeholders to develop a statewide Climate Change Action Plan. The goal is to identify cost-effective measures that government and industry could take to halt the current increase in greenhouse gas emissions within Massachusetts, and ultimately to reduce total emissions.

AP 5.1: PREDICTED SHIFT IN SUGAR APLE'S RANGE FROM GLOBAL WARMING



Source. OSTP, Climate Change: State of Knowledge

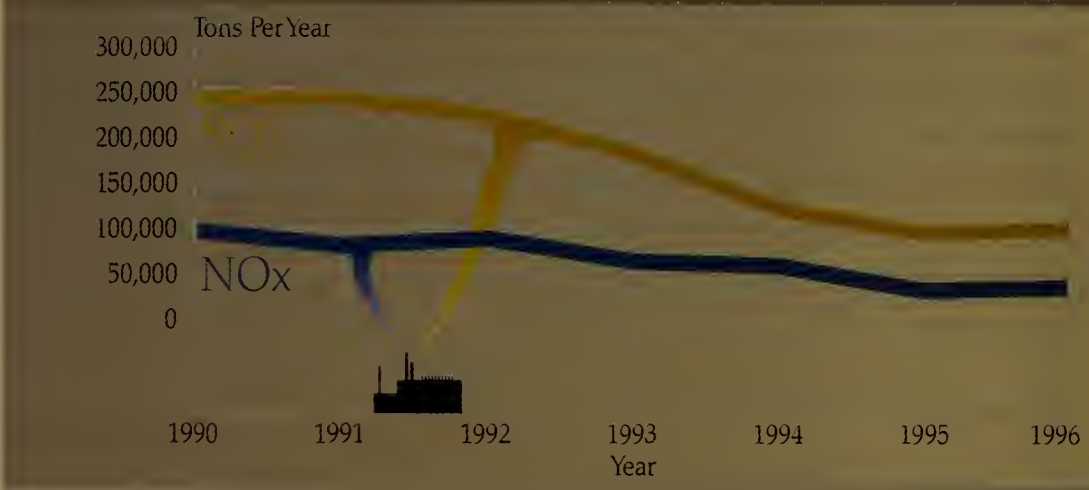
anging patterns of rainfall and temperature will ct ecosystems, and the farms, forests, fisheries, and ieties that depend upon them.

GLOBAL WARMING AFFECTS RARE SPECIES

Although the preservation of wildlife corridors could permit some trees and large animals to shift their range northward as climate changes occur, plants with limited ranges, like the rare ladyslipper orchid, are vulnerable to eradication. (Photo: DFW/Bill Byrne)

5.

ENVIRONMENTAL INDICATOR 5.5: POWER PLANT EMISSIONS OF SMOG AND ACID RAIN PRECURSORS



Source: DEP

Stringent standards have reduced power plant emissions of smog and acid rain precursors. Construction of cleaner new plants spurred by deregulation of the Massachusetts energy industry is expected to continue the trend.

CLEANER ENERGY SOURCES

Massachusetts requires the most stringent standards of any state for cleaner technology and lower emission rates in new power plants. Existing plants, which still rely on fuel oil (and to a lesser extent on coal), remain the principal in-state source of the acid-rain precursor SO_2, and a major source of the smog precursor NOx. The structure of the federal Clean Air Act has effectively "grandfathered" older and dirtier oil- and coal-burning plants from complying with current standards. But through the deregulation of the energy industry in Massachusetts, competitive economic forces promise to produce significant environmental improvements.

At least 16 new gas-burning power plants are currently proposed in Massachusetts. Plants already in the review process or under construction could supply more than 6,000 megawatts of power, a major part of the state's total energy needs. Because they are economically more cost-efficient, these new plants should significantly reduce the state's reliance on its older plants. The shift to cleaner technologies that comply with environmental standards will significantly reduce overall pollution levels from the utility sector.

Governor Cellucci has pledged to reduce impacts from the state's oldest and dirtiest plants. The goal is to reduce smog and acid rain precursors 50% to 75% by 2003. In response to community concerns, some power providers have already voluntarily agreed to shut down existing oil-fired units (for example, in Everett and Sandwich) in favor of cleaner, more efficient methods of power generation.

As emissions from Massachusetts power plants and factories are falling, a correspondingly larger portion of the smog and acid rain in our state is being caused by upwind sources, chiefly coal-burning power plants in Midwestern states. In response to a petition from Massachusetts and several other Northeastern states, EPA recently began an enforcement action against 40 Midwestern power plants to address the long-distance transport of smog.

The act that deregulated the state's power industry created a fund that will invest $150 million over the next five years in renewable energy sources. The act also required all electricity suppliers to include increasing levels of power from renewable sources, starting in 2003.

CLEANER POWER SOURCES

Cleaner, more efficient natural gas power plants are being developed in Massachusetts, reducing our dependency on older, dirtier facilities that run on oil or coal. The 1998 deregulation of the energy industry is expected to accelerate this trend. (Photo: EOEA)

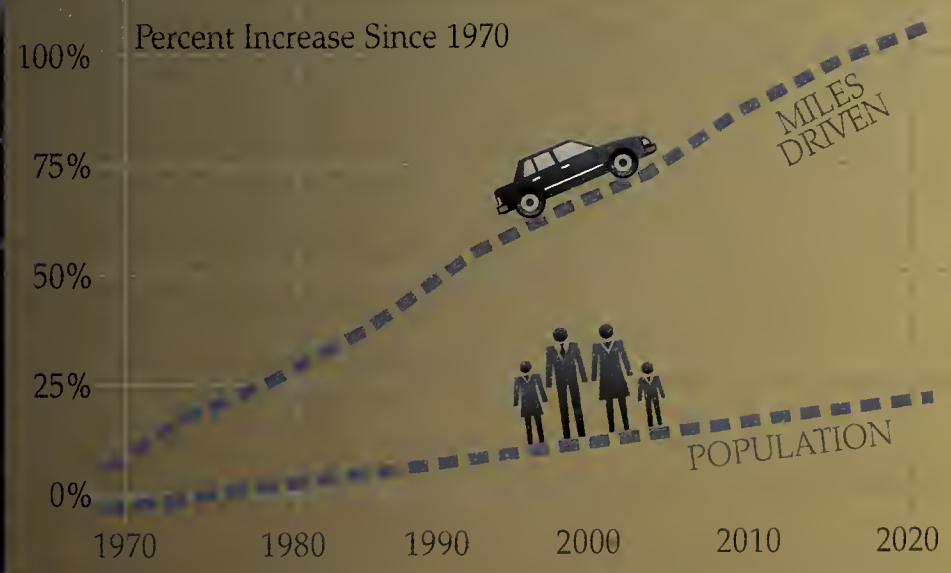
TRANSPORTATION: CLEANER VEHICLES, BUT DRIVING MORE

Because our car- and truck-based transportation system relies almost entirely on gasoline and diesel fuel, it is the biggest source of smog-producing VOCs and NOx, greenhouse gases, and CO. Tough federal and state emission standards for new vehicles, and the state's new inspection and maintenance requirements for vehicles already on the road, have dramatically reduced the pollution rate from individual cars and trucks. The fact that, on average, we are driving longer and longer distances each year, however, largely due to dispersed sprawl patterns of development, is canceling out many of these gains — so much so that statewide NOx levels, after falling for years, are now predicted to begin rising again within the next five years.

Since 1970, the requirements of the federal Clean Air Act have dramatically reduced air pollution from cars and trucks. Emission rates have declined 80% to 95%, depending on the type of pollutant measured. Diesel truck emissions have also gone down, though less dramatically: 10% to 60%.

To improve air still further, Massachusetts has joined California in adopting the nation's most stringent vehicle emissions standards. Starting in 2003, 10% of all new cars sold in Massachusetts must be either Zero Emission Vehicles (ZEVs), totally clean-fuel vehicles that run on electricity or hydrogen fuel cells, or advanced clean vehicles that use new and innovative technologies. One example is a "hybrid" car that uses a very small internal combustion engine to charge its main electric motor. Two such cars, the Honda Insight and the Toyota Prius, each delivering 60-70 miles per gallon, will be on the American market by the end of 2000.

ENVIRONMENTAL INDICATOR 5.6: GROWTH IN VEHICLE MILES TRAVELED SINCE 1970



Tough federal and state emission standards for new cars, and the new inspection and maintenance program for vehicles already on the road, have dramatically reduced air pollution per vehicle. But sprawl development patterns cause us to drive farther and farther, canceling out much of the gains.

5.

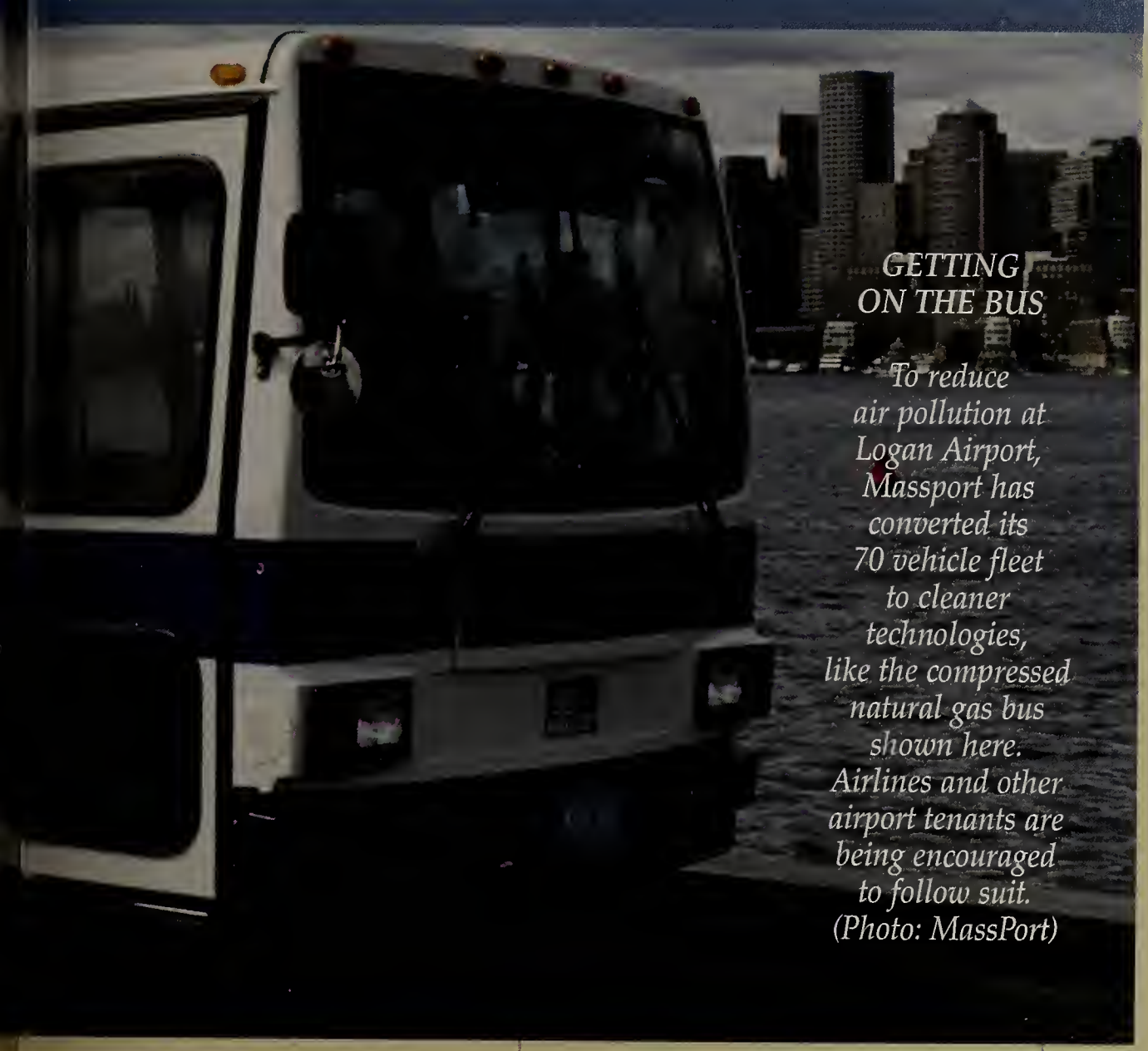
ENVIRONMENTAL INDICATOR 5.7:
CARBON EMISSIONS FOR DIFFERENT TRAVEL MODES

Source: EOEA

The choice of which car to buy is the single most important environmental decision that most consumers will make. The best way to reduce vehicle emissions is to drive less, and to walk, bicycle, or take public transit whenever possible.

For most consumers, deciding which new car to buy is the single most important environmental decision they will make. Selecting a car with greater fuel efficiency and lower emissions will reduce pollution for every mile driven. For example, the popular sport utility vehicles (SUVs) emit, on average, twice the amount of smog precursors and three times the amount of greenhouse gases per mile as an ordinary sedan.

Manufacturing requirements don't do any good, however, if the air pollution control equipment in a car is not working properly. A small number of poorly tuned cars can cause big health problems for everyone else. Studies have shown that one-half of all pollution from cars and trucks is caused by the dirtiest 10% of the vehicles on the road.



GETTING ON THE BUS

To reduce air pollution at Logan Airport, Massport has converted its 70 vehicle fleet to cleaner technologies, like the compressed natural gas bus shown here. Airlines and other airport tenants are being encouraged to follow suit. (Photo: MassPort)

Massachusetts has improved and expanded the inspection and maintenance of air pollution controls, as part of the general inspection process. The computerized inspections that began in October 1999 measure accurately the amount of smog-causing VOCs and NOx spewing out of a car's tailpipe — and out of the tailpipes of trucks and buses, which were not previously tested for air pollution. This program, which is one of the most cost-effective methods of pollution prevention, is predicted to eliminate 120 tons of pollution each day.

The best way to reduce air pollution from transportation sources is to drive less and to walk, bicycle, or take public transit whenever possible. The Massachusetts Bay Transportation Authority (MBTA) runs the nation's fifth largest transit system. Every day the MBTA carries 649,000 passengers on its subways and trolleys, 360,000 on its buses, and 120,000 on its trains. Up to two-thirds of all commuters into downtown Boston get to work by riding the T or walking. The MBTA has made major new investments in expanding the transit system in the metropolitan Boston region. Commuter rail service has been restored to many communities. Portions of the first new transit line in several decades, the Silver Line from Roxbury through downtown into South Boston, is under construction.

Even with these extensive transit systems, car travel accounts for 85% of all miles traveled in Massachusetts. Due to sprawl development patterns, Massachusetts residents are driving farther and farther. Total vehicle miles continue to rise much faster than the population. This increase in vehicle miles traveled is cancelling out emissions improvements that would otherwise be brought about by cleaner cars.

Airports are another transportation-related source of air pollution that has not been aggressively regulated in the past. Emissions from airplanes (which are exempt from the Clean Air Act), travel to and from the terminals, and ground service vehicles that service the planes, have made Logan Airport the fifth largest single source of NOx in the state. The environmental agencies are now working with Massport, under the provisions of the Massachusetts Environmental

5.

Policy Act (MEPA), to create a first-in-the-nation program for controlling airport pollution. The program would seek to reduce airport emissions, both from on-site ground equipment and aircraft, and from other facilities that affect the same area communities.

The pollution created by off-road equipment (everything from lawnmowers and chainsaws to snowmobiles and construction equipment) has been much less effectively regulated than the emissions of cars and trucks. Operating a gasoline-powered chainsaw for one hour creates as much smog-inducing VOCs as driving a new car from Boston to Dallas; operating a gasoline-powered snow-blower for an hour is the equivalent of driving the same car from Dallas to Los Angeles.

MOVING TOWARDS CLEANER CONSTRUCTION

The Central Artery project has spearheaded a demonstration project to retrofit construction equipment in Boston, significantly improving air quality for construction workers and neighboring communities. (Photo: NESCAUM)

KIDS COME UP ACE'S IN BID FOR CLEANER AIR

Seventeen-year-old Tamica Davis and a few of her friends were sick and tired of breathing diesel fumes from MBTA buses idling in Dudley Square, in Boston's Roxbury neighborhood. Davis had an added incentive to do something about it; she suffers from asthma.

Enter Jodi Sugerman-Brozan and Klare X. Allen, from Alternatives for Communities and Environment (ACE). An environmental justice advocacy group, ACE helps develop community solutions to the excessive burden of environmental degradation borne by those living in poor and minority urban neighborhoods. Sugerman-Brozan and Allen talked to the kids at their school, telling them about an idling time limit for the buses imposed by a Department of Environmental Protection regulation.

"So how can we enforce that law?" Tamica asked.

In September of 1998, with support from ACE, the kids decided to do something about the problem. They held a "Breathe Out," an environmental version of a "sit-in," in Dudley Square and invited the media.

The T complied with their requests to limit idling, and the kids say that the drivers now generally obey the time limit. If they don't, Davis and the other ACE interns politely ask the drivers to shut down their engines.

The kids learned a valuable lesson from the experience. "Because we don't vote yet, we didn't know we could change our community in a positive way," said Stanley Wiggins, 17, another ACE intern.

The kids have now turned their attention to getting buses with cleaner fuels, and more bus shelter locations in their neighborhoods.

5.

GREEN BUILDINGS

EOEA is using the Clean State program and the MEPA review process to ensure that new publicly funded buildings incorporate "green building" strategies, to serve as models for the private sector. The heating and cooling systems of buildings are a major energy user, generating both smog precursors and greenhouse gases. Buildings can be designed to maximize solar gain in the winter and natural ventilation in the summer; to use as much natural light as possible; and to generate electricity through solar cells. Green buildings can also support other environmental goals. Built-in collection systems encourage recycling. The reuse of stormwater or treated "gray" wastewater for toilets and other non-potable purposes conserves drinking water.

GREEN DEVELOPMENT

Commercial buildings are major energy consumers. These solar panels at the Porter Square Shopping Center in Cambridge generate 40,000 kilowatt hours of electricity per year – one-third of the project's total need. (Photo: Gravestar, Inc./Murphy & Murphy)

WHAT SHOULD BE DONE

By State Government

- Expand efforts to measure, evaluate, and reduce the impact of air pollution on public health and the environment, including regional efforts to address acid rain, smog, and mercury.
- Complete and implement the Climate Change Action Plan.
- Implement environmental provisions of utility deregulation to ensure cleaner energy production and efficient energy use.
- Encourage the transition of state vehicle fleets, including the MBTA, to clean-fuel technologies, and the retrofitting of existing diesel buses to reduce particulates.
- Expand the Clean State Initiative and utilize the MEPA review process to promote green building strategies.
- Implement a program to maintain and provide incentives to reduce emissions at Logan Airport.

By Local Governments

- Purchase "green power" from renewable sources for schools and other public facilities.
- Modify local zoning to encourage more dense, mixed-use, transit-oriented developments that reduce dependence on automobile travel. Set maximum, as well as minimum, parking requirements.
- Develop local bike path and pedestrian walkway networks.

By Business

- Encourage employees to use alternative modes of transportation by subsidizing transit passes and ridesharing, and by providing racks and showers for bicyclists.
- Pursue "green building" strategies that reduce energy use, air pollution, and greenhouse gas emissions.
- Choose low-VOC products for better indoor and outdoor air quality.

By Citizens

- Use public transportation, join a carpool or vanpool, or consider walking or bicycling to your destination when possible. Ask your employer to organize a ridesharing program and offer transit passes.
- When buying a car, new or used, look for the most fuel-efficient, lowest-emissions car that meets your needs.
- Plan trips to combine several errands, and limit unnecessary "impulse" travel. Keep your car properly maintained.
- Get a free home energy audit from your gas or electric utility. Follow through on installing cost-saving items such as insulation, energy-efficient lights, and setback thermostats.
- Use electric or low-emission lawnmowers, chainsaws, and other equipment.

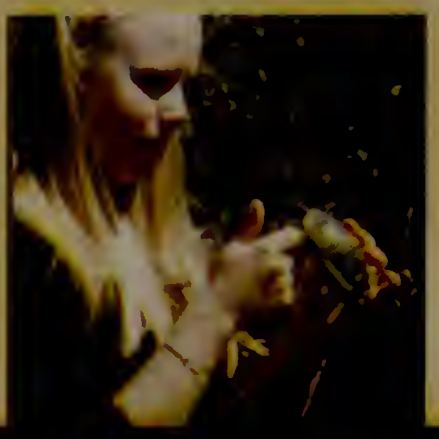
6.

BIODIVERSITY

THE STATE OF OUR

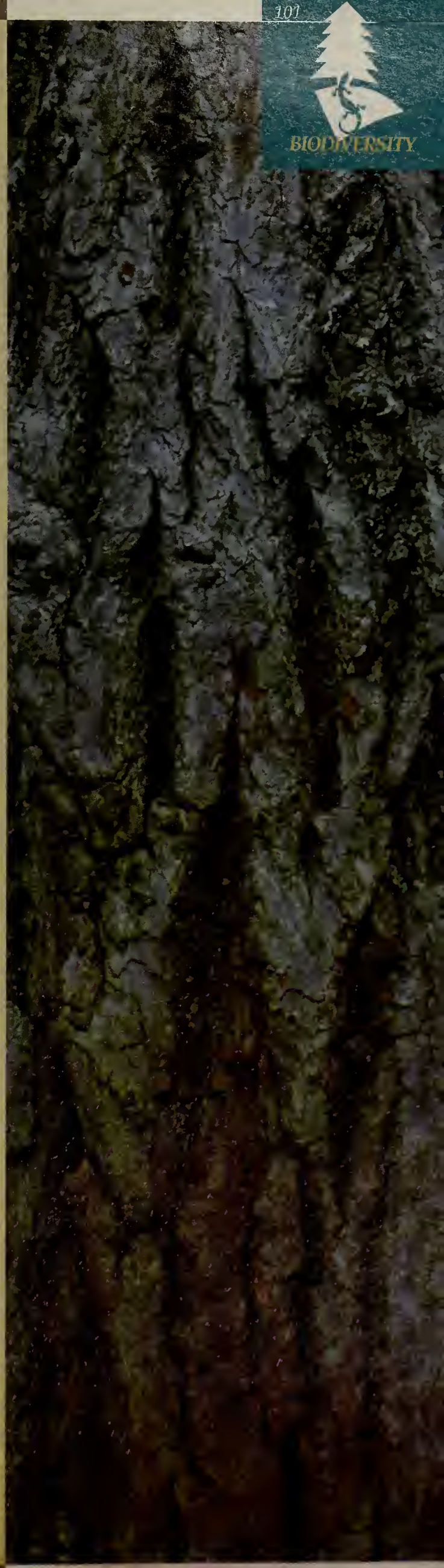
NATURAL

COMMUNITIES



Biodiversity is a term used by scientists
to measure the variety of different kinds
of organisms found in a certain place.
Each species is an irreplaceable natural resource,
the product of thousands or perhaps millions of
years of evolution. The loss of any single species
may affect the health of an entire ecosystem —
and our own health as well —
in subtle but profound ways.
For example, up to 40% of all modern
medicines are derived from wild species.
It is in our self-interest to protect biodiversity —
not only in the Amazon rainforest,
but right here in Massachusetts.
Our food, our wood, our clothing,
the purity of our water,
and the very air we breathe, all depend upon
the natural communities around us.

At least 15% of the larger animal and plant species
in Massachusetts are currently listed as rare.
Protecting biodiversity will require a transition
to a truly sustainable way of life, which limits
the stresses on natural ecosystems to levels
that they can support. The two biggest threats to
biodiversity in Massachusetts are the destruction
and fragmentation of wildlife habitats and the
introduction of invasive non-native species.
Both of these forces affect the natural
communities in which living creatures
coexist and depend upon each other.
By preserving eight critical natural communities
that are under stress in Massachusetts,
we can ensure the future of
70% of our rare species.
The challenge of sustainability is particularly
acute for the forests and the fisheries
(see Chapter 7), both of which still support
important sectors of the Massachusetts economy.



6.

ECOREGIONS AND NATURAL COMMUNITIES

For a small state, Massachusetts has a great richness of lifeforms. Over 400 species of birds, 91 species of mammals, 51 species of reptiles and amphibians, and 1,650 species of vascular plants (trees, shrubs, flowers, and ferns) have been recorded in the state. And yet this is only a fraction of the total; the number of insects and other invertebrates, fungi, algae, and single-celled organisms is unknown, but can undoubtedly be measured in the thousands — if not tens of thousands. Where all these creatures live, and in whose company, is highly predictable, as shown by the concepts of ecoregions and natural communities.

Ecoregions are large areas, often extending for hundreds of miles, that share common characteristics of landforms, soils, water, and plant life. Biologists have divided the entire northeastern United States into two major ecoregions, with a border that loops through the middle of Massachusetts (see Map 1.1). Each ecoregion is divided into subregions, based largely on elevations and soils.

All of the land west of the Connecticut Valley, as well as the northern Worcester Plateau, falls into the Northeastern Highlands ecoregion. Ecologically, this is the beginning of the great northern forest — maples, beeches, and birches, with firs and spruces at higher elevations — that extends into northern Maine, and west into the Adirondacks and Ontario.

The warmer temperatures and longer growing season that characterize the Connecticut Valley, the southern Worcester Plateau, and the entire coastal zone, defines the Northeastern Coastal Zone ecoregion. Most of the Coastal Zone ecoregion is dominated by a mixture of oaks and hickories, part of a hardwood forest that extends south along the Appalachians as far as Georgia. But on the sandy glacial soils of southeastern Massachusetts, Cape Cod, and the

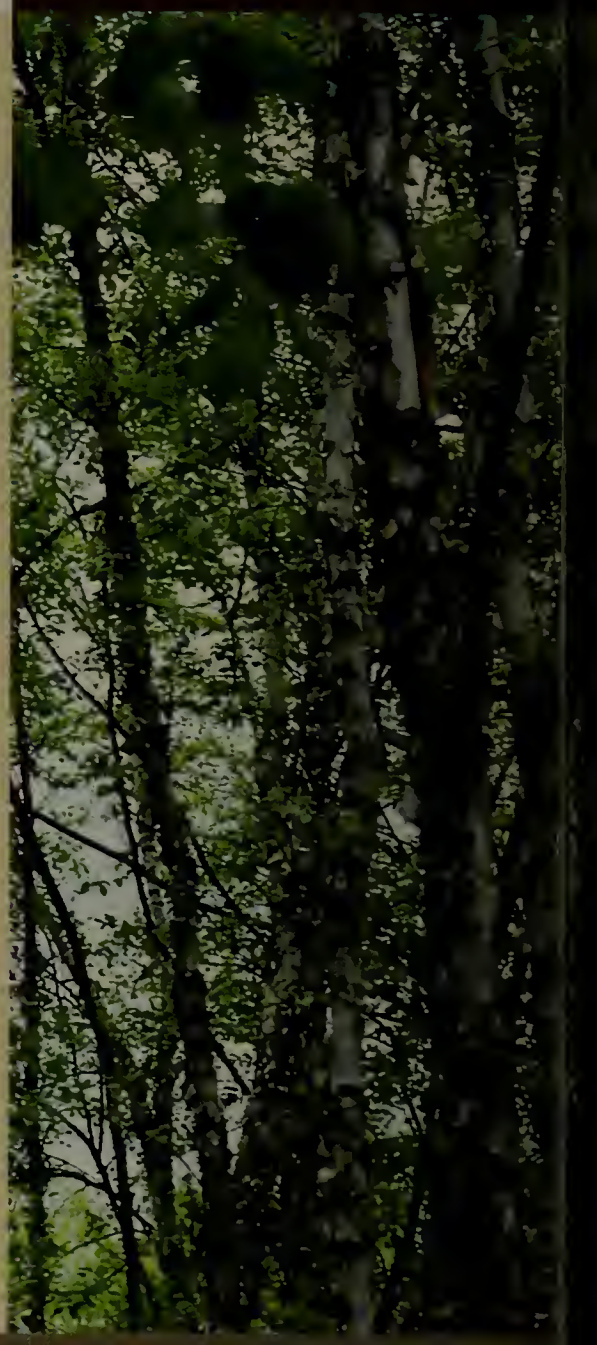
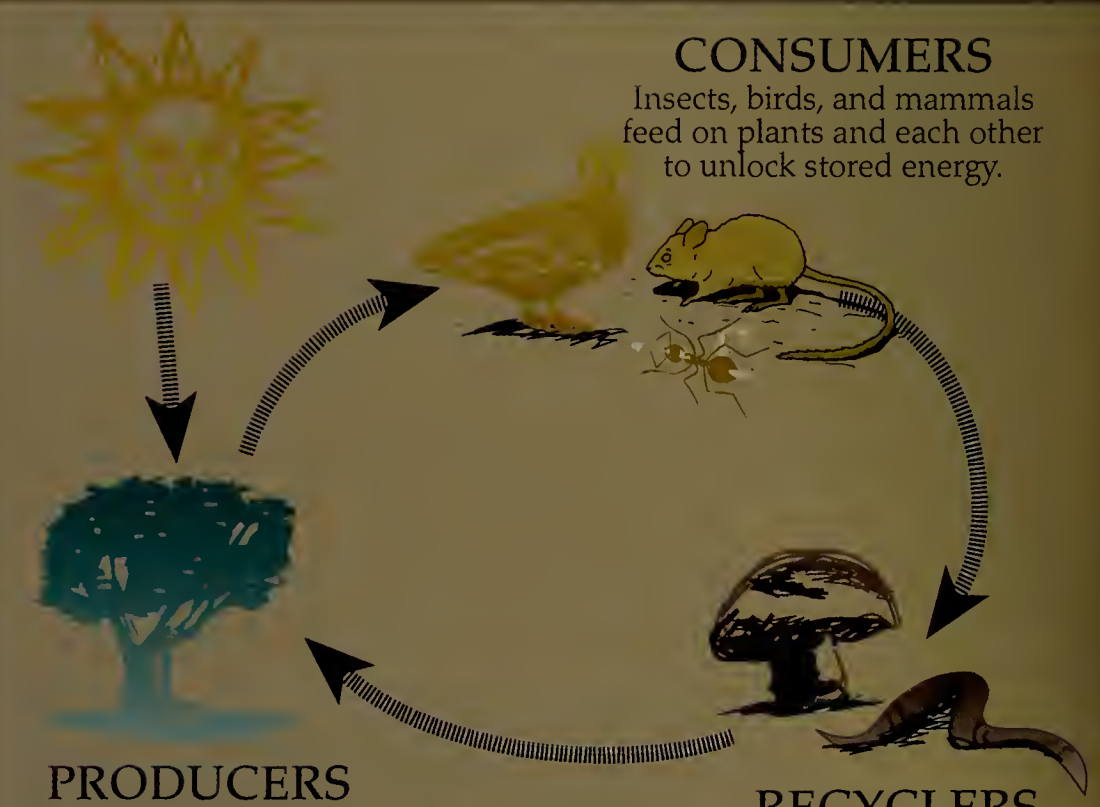


DIAGRAM 6.1:
FOOD CHAIN IN A FLOODPLAIN FOREST


CONSUMERS
Insects, birds, and mammals feed on plants and each other to unlock stored energy.
PRODUCERS
Trees, flowers and ferns use solar energy to create plant material.
RECYCLERS
Worms, fungi and bacteria break down dead matter into nutrients.

Source: EOEA

The members of each natural community form a complex web of life. The loss of any single species can affect the entire community.

HAVENS FOR BIODIVERSITY

Floodplain forests have been identified as one of the eight key natural community assemblages that are critical to protecting biodiversity in Massachusetts. The 1996 Rivers Protection Act extended new legal protections to these habitats. (Photo: DFW)

Islands one finds a distinctive pitch pine-scrub oak forest, similar to that found on Long Island and in the New Jersey Pine Barrens.

A natural community is a more localized grouping of plant and animal species that tend to cluster together wherever the conditions are right. Each ecoregion and subregion is a mosaic of different natural communities. Scientists have described over 100 different natural communities within Massachusetts. Some are broadly distributed. The northern hardwood forests of the Berkshires and the pitch pine-scrub oak barrens of the southeast may continue unbroken for miles; red maple swamps are widely found throughout the state. Others, like coastal sandplains, white cedar swamps, and northern peat bogs, occur in only a very few places.

No matter how large or small a natural community may be, its members form a complex web of life. Each natural community includes plants that capture solar power to fuel their own growth while giving off oxygen, animals that depend upon the plants and one another for food and shelter, and organisms that decompose dead matter back into valuable nutrients. The loss of any single species can affect the entire community.

6.

HABITAT FRAGMENTATION

Habitat destruction and fragmentation, shown here at a new housing subdivision in the southeast, is the principal threat to biodiversity in Massachusetts. (Photo: EOEA

HABITAT LOSS AND INVASIVE SPECIES

Despite the passage of tough federal and state endangered species laws, the biodiversity of Massachusetts wildlife is threatened. The percentage of native species listed as rare by the Division of Fisheries and Wildlife (DFW) ranges from 13% of mammals and 15% of both breeding birds and vascular plants, to 29% of amphibians and 53% of reptiles. These figures do not count the seven species formerly found in Massachusetts that are now globally extinct, or the approximately 75 species that have been eradicated in the state, but still survive elsewhere.

The list of lost species includes some of the biggest and most abundant animals encountered by early European settlers. The last elk in Massachusetts was killed by 1732, the last Atlantic gray whale by 1750, the last gray wolf by the 1820s, and the last cougar by 1858. Unregulated hunting also killed off the great auk (a larger relative of the puffin), which once wintered off the coast, and the passenger pigeon, once the most abundant bird in North America, which migrated in hundred-mile-long flocks numbering in the billions. No one will ever know how many species of smaller invertebrates and plants have also disappeared since the seventeenth century, unnoticed and unmourned.

Massachusetts has been a pioneer in the passage of wildlife

management laws. The first closed season on deer was established here in 1694, and the first game wardens were appointed in 1739. The efforts of the Massachusetts Audubon Society, founded in 1896, were instrumental in getting Congress to pass the Lacey Act, the first federal wildlife protection measure, in 1900. In 1990 the Massachusetts legislature passed the state Endangered Species Act, which forbids any direct or indirect harm to any state-listed rare species, including any alteration of its breeding habitat.

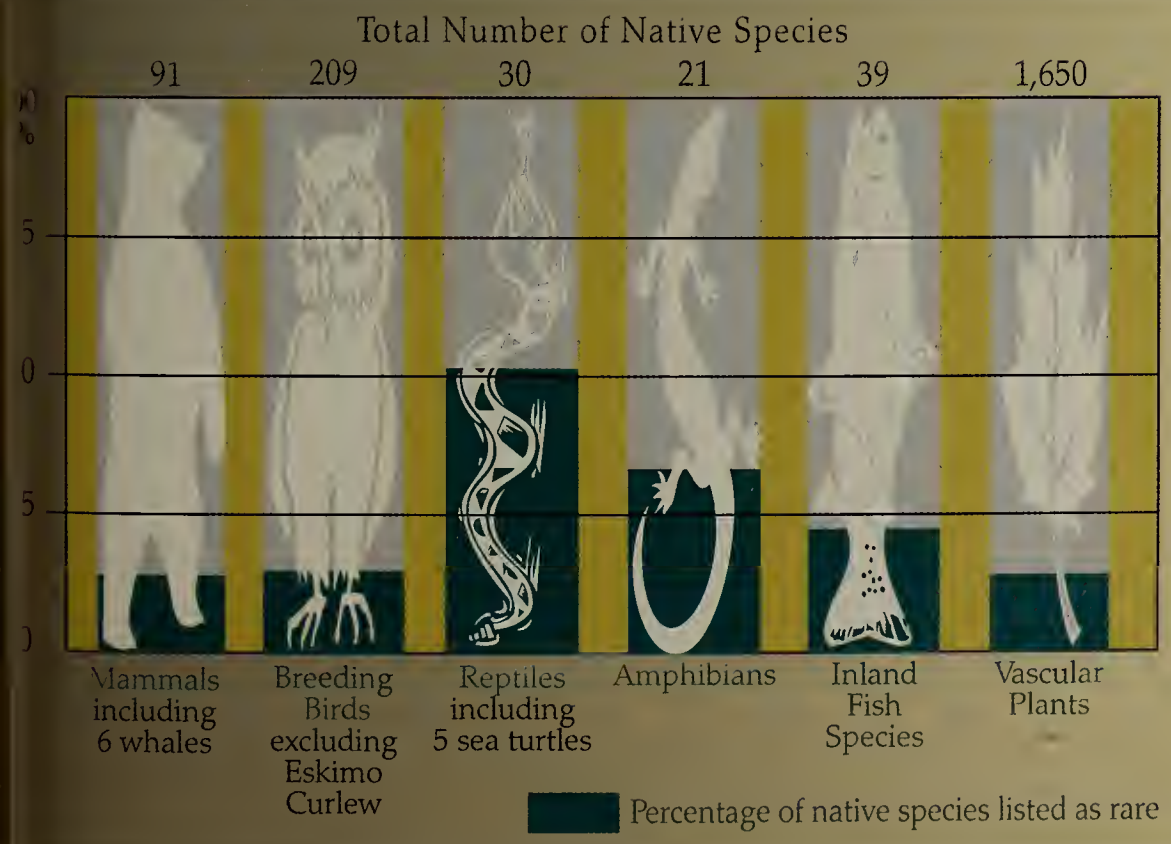
Today, habitat loss is the principal threat to biodiversity in Massachusetts. Sprawl development patterns have accelerated the destruction and fragmentation of breeding grounds for all species. Habitat loss is not limited to the times when a tract of land is bulldozed and paved over. There is a certain minimum area, often containing several different habitats, that the population of every species needs to be able to sustain itself. For example, most salamanders feed and breed in vernal pools and spend the fall and winter underground in the surrounding uplands. By contrast, a red fox may spend most of its life in upland forests or meadows, but depend on ponds, streams, and other wetlands for water and additional food. Foxes and many other species also require large areas of connected land where they can search for new food sources, and where their offspring can disperse to new territories.

When a forest or other habitat is fragmented into smaller pieces by new roads and houses, these man-made barriers divide and isolate the natural populations — even though there may still appear to be an abundance of trees or open space. Smaller, isolated populations are more vulnerable to stresses — diseases, food shortages, and predators — and less able to maintain themselves at a sustainable level.

Protecting wildlife habitat does not mean halting development; it means planning development with greater regard for its effects on biodiversity. DFW has completed a statewide mapping of the estimated habitat of every state-listed rare species. With advance planning and the use of more compact "cluster" site layouts, new developments can be reconfigured to avoid the most sensitive areas and minimize habitat fragmentation.

The second most critical threat to biodiversity is that posed by invasive species that were not originally native to Massachusetts and its ecosystems, but which are now displacing, destroying, or outcompeting native species. The first European settlers brought along with them a host of other plants, animals, and diseases that were well adapted to human settlements. Three of the most

NVIRONMENTAL INDICATOR 6.1:
'ERCENTAGES OF SPECIES LISTED AS RARE



Source: DFW/TNC, Our Irreplaceable Heritage

)espite federal and state endangered species laws, the biodiversity of Massachusetts is threatened. Listings of rare species do not count seven)ecies that are now globally extinct, or approximately 75 species that ave been eradicated in the state.

6.

common city birds — rock doves (pigeons), starlings, and house sparrows — were all originally foreigners; so were many of our most familiar roadside flowers and weeds, including daisies, dandelions, and stinging nettles. Some native species are also considered invasive because they have become so widespread, often in response to human disturbance of the environment. A hybrid form of the common reed (*phragmites*), whose native relative was once confined to the uplands of coastal marshes, is expanding along rivers and roadsides into inland areas.

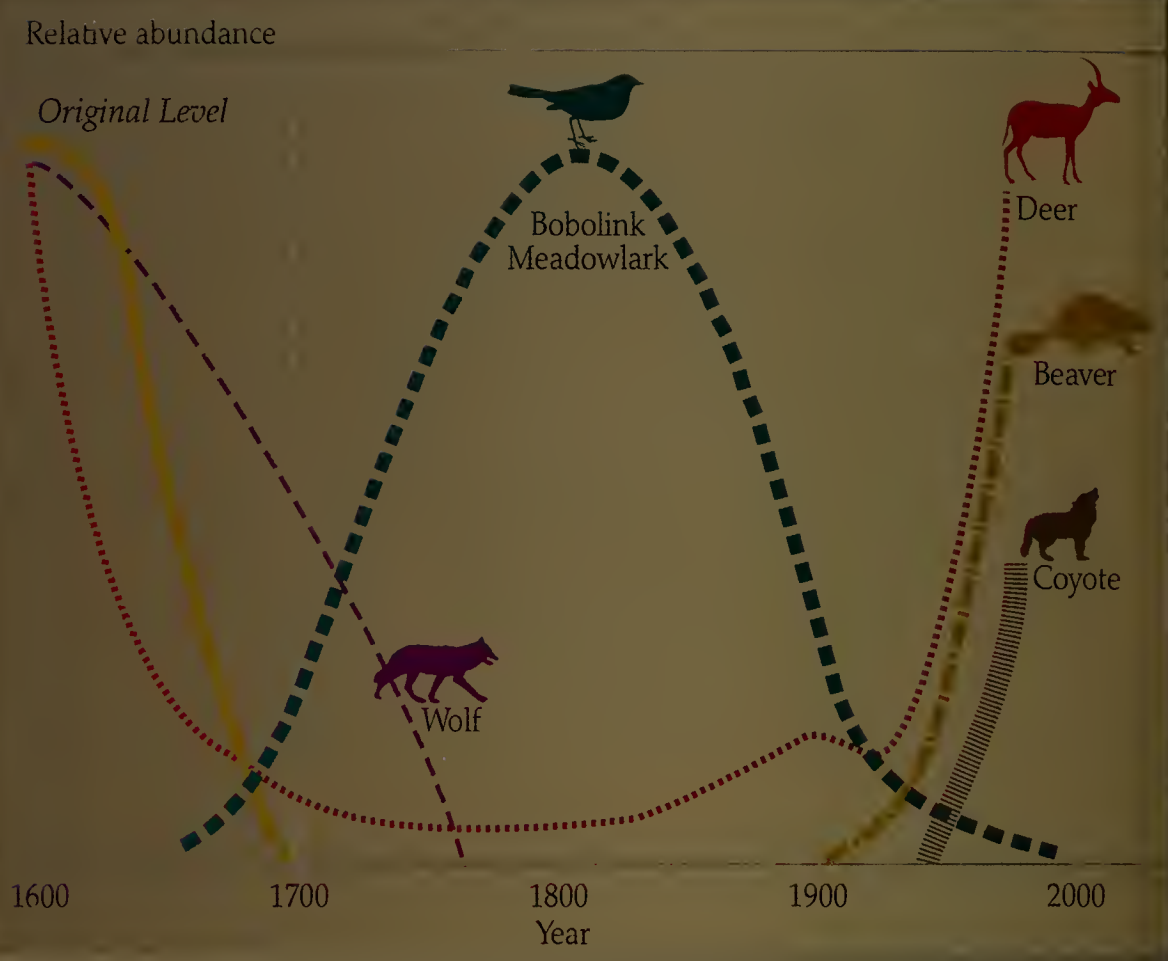
Sometimes an invasive species can threaten an entire ecosystem. The hemlock woolly adelgid, an Asian aphid the size of a period on this page, now infests hemlock trees in nearly one-quarter of all Massachusetts cities and towns, weakening and often killing the trees. This infestation is so serious because the hemlock is a key component of Massachusetts forests, second only to the red maple in abundance and providing food and shelter to many species of mammals and birds.

The combination of these two forces — habitat loss and fragmentation, and invasive species — explains why many seemingly green areas do not actually support a high level of biodiversity. In city parks, suburban backyards, and highway margins, one may find large numbers of highly adaptable species, such as gray squirrels, common crows, dandelions, and *phragmites*, but little else.

One can point to some dramatic examples of the restoration of individual species. Wild turkeys, beavers, and fishers (a larger relative of the weasels), all vanished by the nineteenth century, have been restored to the forests. Black bears and white-tailed deer, both of which were barely holding on in 1900, are also expanding in range and numbers. Bald eagles and peregrine falcons, affected by habitat loss and by DDT and other now-banned pesticides, resumed breeding in the state in the 1980s, helped by active restoration efforts.

But the restoration of individual species is a slow, costly, and chancy process. For every success story, there is a less-well-known failure. Once destroyed, habitats are not easily restored; not only can the process be very expensive, but also it is usually impossible to identify all the necessary elements of the original ecosystem. That is why the best way to protect and expand biodiversity in Massachusetts is to preserve the natural communities in which rare species live.

ENVIRONMENTAL INDICATOR 6.2: CHANGES IN KEY ANIMAL POPULATIONS, 1600 - 2000



Source: Foster, ed., Stepping Back to Look Forw

Hunting and deforestation eradicated or dramatically reduced many k animal species by the 19th century. As the forests have returned, man woodland species have recovered, while grassland species have declined.

BIODIVERSITY

VASIVE PECIES

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PRESERVING NATURAL COMMUNITIES THROUGH BIORESERVES

Our Irreplaceable Heritage, a recent report issued by DFW and The Nature Conservancy, shows that the concentration of rare species is much greater in certain of the state's ecoregions — notably those areas where there has been rapid recent land development, such as Cape Cod and the Islands, the southeast, and the Connecticut Valley. The report identifies eight specific natural communities within those ecoregions that are particularly at risk. These include coastal sandplains, pine barrens, river valleys, white cedar swamps, peat bogs, and calcareous wetlands.

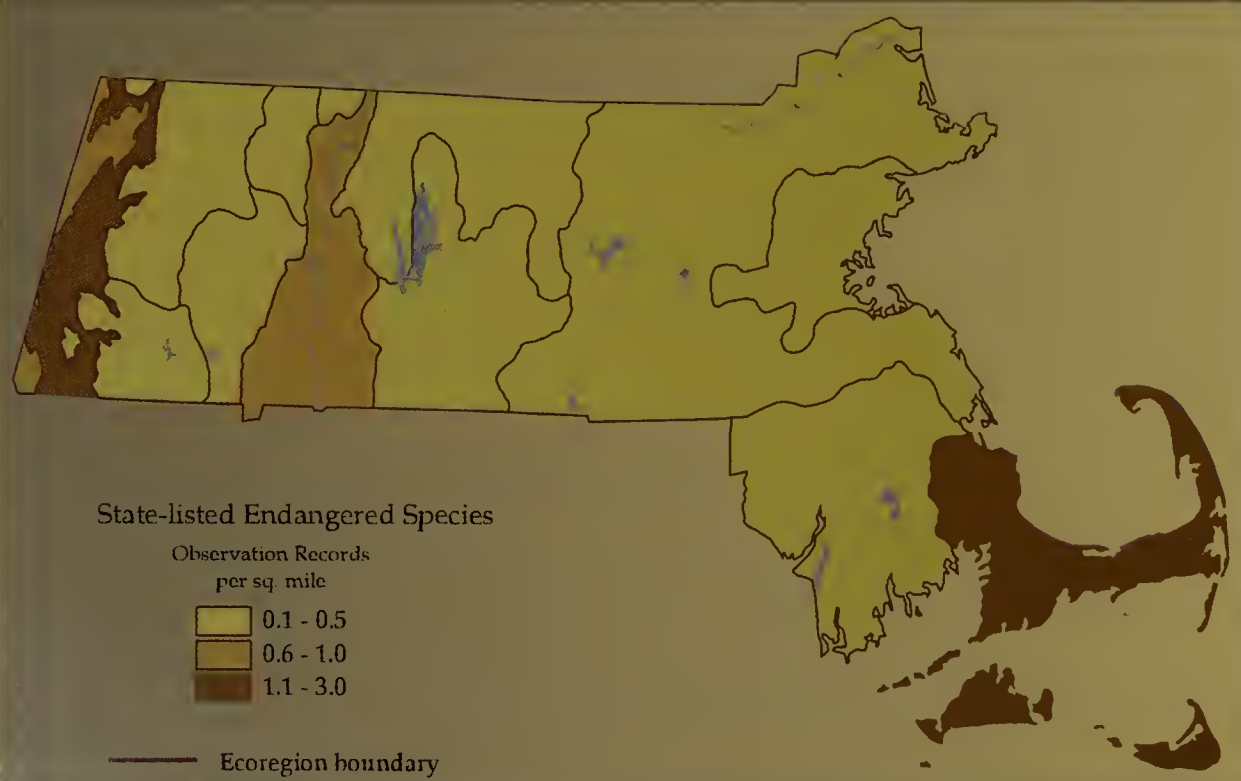
A next step will be a statewide scientific process of biomapping. This will identify with greater precision the most significant areas for preserving biodiversity, based on rare species, natural communities, and ecoregions.

The focus on preserving biodiversity within Massachusetts by protecting the full array of its natural communities and ecoregions will require the creation of a statewide system of bioreserves. The concept draws upon the global network of Biosphere Reserves initiated by the United Nations Educational, Scientific and Cultural Organization (UNESCO).

The bioreserve concept seeks to balance biodiversity with economic development and maintenance of cultural values. Each bioreserve will contain a core area of one or more major public open space holdings, surrounded by a buffer zone of mixed public and private lands used for ecologically compatible purposes, and then by an outer transition zone of mainly private lands. Biodiversity goals would help unify and guide all of the state's land protection, management, and regulatory activities within the identified bioreserve area.

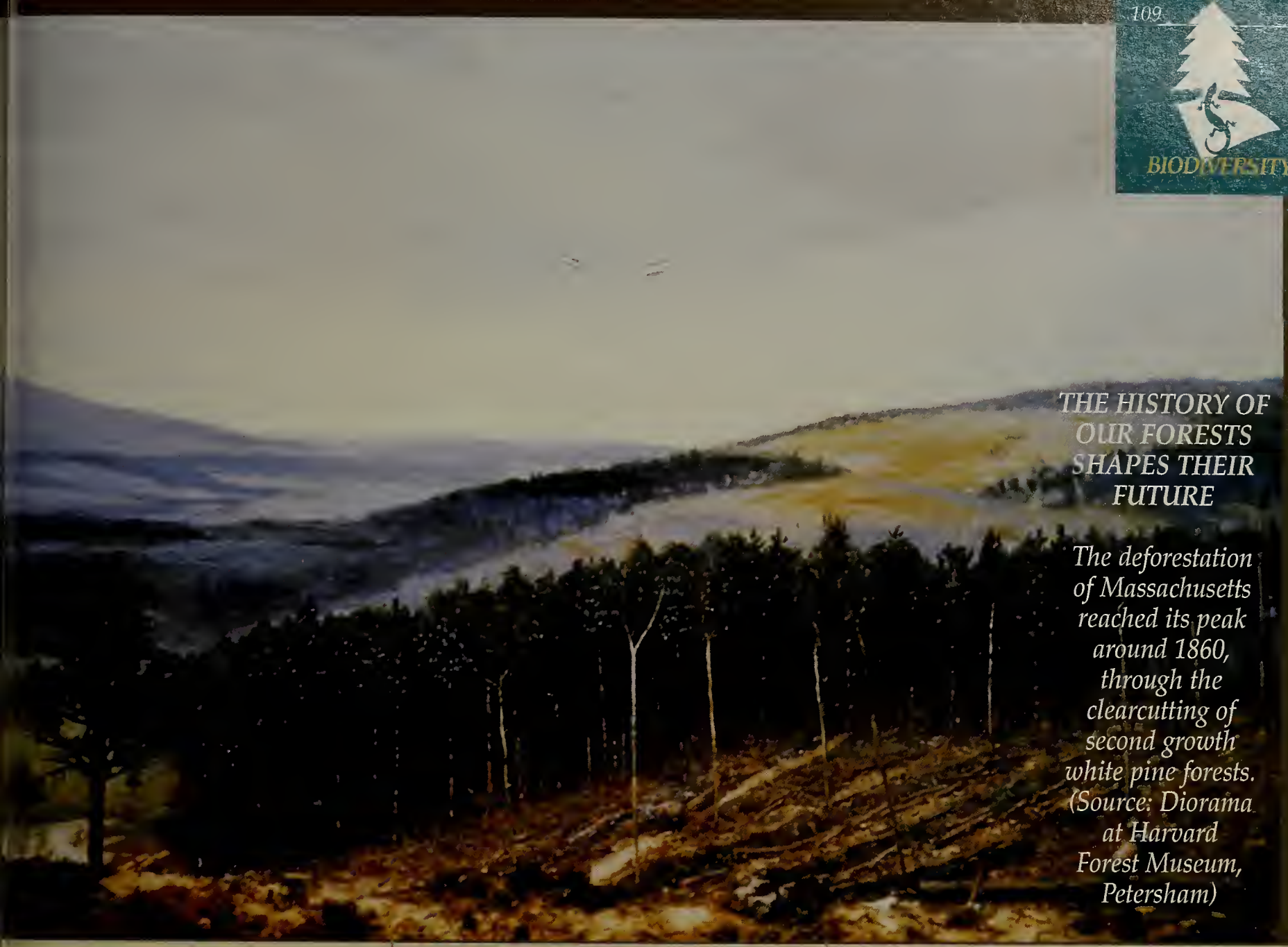
The Massachusetts bioreserve program ultimately aims to create at least one reserve within each of the state's ecoregions and subregions, on land and in the water. Those ecoregions where biodiversity is under the greatest stress will receive priority in establishing the first bioreserves.

MAP 6.1: ECOREGIONS WITH THE MOST RARE SPECIES



Source: DFW/TNC, Our Irreplaceable Heritage

The concentration of rare species is greatest in those ecoregions where there has been rapid recent land development, notably Cape Cod and the Islands, the southeast, the Connecticut Valley, and the lower Berkshires.



THE HISTORY OF OUR FORESTS SHAPES THEIR FUTURE

The deforestation of Massachusetts reached its peak around 1860, through the clearcutting of second growth white pine forests. (Source: Diorama at Harvard Forest Museum, Petersham)

ENVISIONING HEALTHIER FORESTS

The recovery of the Massachusetts forest since the nineteenth century is one of the most remarkable environmental changes the state has witnessed in the past hundred years. Today 62% of the state, 3.2 million acres of land, is forested — more than twice as much as in 1870. Forests provide homes for wildlife, recreational opportunities for hiking and camping, natural filtration systems for drinking water, and economic resources for the timber industry. But the forests, like other elements of the state's biodiversity, are threatened by habitat destruction and fragmentation and invasive species.

EOEA's Forest Vision Project seeks to preserve the ecological health of the Massachusetts forests. The project will develop a biodiversity-based approach to managing public and private forest lands, coupled with timbering practices that respect the safe yield of the resources and land development policies that steer growth toward appropriate areas (see Chapter 2).

The different types of forest in Massachusetts reflect the state's different ecoregions: pitch pine-scrub oak barrens in the southeast, hickory-oak hardwoods in the coastal zone and the Connecticut Valley, northern hardwoods in the highlands, and northern spruce-fir forests on the highest summits of the Berkshires and Taconics. These forests are almost entirely second growth; only tiny portions of the state have never been lumbered. As Chapter 1 describes, Massachusetts

was largely deforested during the eighteenth and nineteenth centuries, in part by the clearing of woods for fields and pastures and in part by the firewood needs of homeowners and the railroads for heating and for fuel. By 1860, 70% of the state had been cleared.

This human history has profoundly shaped the forests. As marginal farms began to be abandoned in the 1840s and 1850s, the old fields quickly grew up into dense stretches of white pines, fast-growing trees that need relatively large clearings to thrive. These second-growth forests proved an excellent source of wood for packing boxes to contain the products of the mills and factories of the new industrial economy. For this reason a second wave of clearcutting swept across the forests between the late nineteenth century and 1910, to be succeeded by younger second-growth forests that are mostly hardwoods — red maples in wet areas, oaks and hickories on drier uplands.

As a result of this history, instead of the small-scale patchwork of young and old trees of different species that would be the result of successive windstorms, icestorms, and fires, in most places one sees sharp breaks between large stretches of forest where all trees are the same age and size, and often dominated by a single species. Such forests tend to support smaller, less diverse populations of wildlife. They are also more vulnerable to invasive pests like the gypsy moth, dutch elm disease, and the hemlock woolly adelgid.

ENVIRONMENTAL INDICATOR 6.3:
DECLINE AND RECOVERY OF OUR FORESTS

Source: Foster, DEM

Forests have recovered remarkably since the peak of deforestation around 1860, but the character of the forests has been shaped by their history. In many second-growth areas all trees are the same age, size, and species, instead of the small-scale patchwork produced by long-term natural forces.

Active management, including selective timbering and preventive burns, is often necessary to protect the ecological health of forests. Active management particularly seeks to increase the area of young "early successional" forests.

As the forests mature, their economic value for timbering increases. The state's timber industry currently produces approximately 80 million board feet of lumber and 200,000 tons of wood chips annually, worth approximately $300 million. Yet 90% to 95% of the forest products consumed within Massachusetts are produced out-of-state. There is a clear potential for increasing the yield of the forests at the same time that we implement biodiversity-based management practices through the Forest Vision Project.

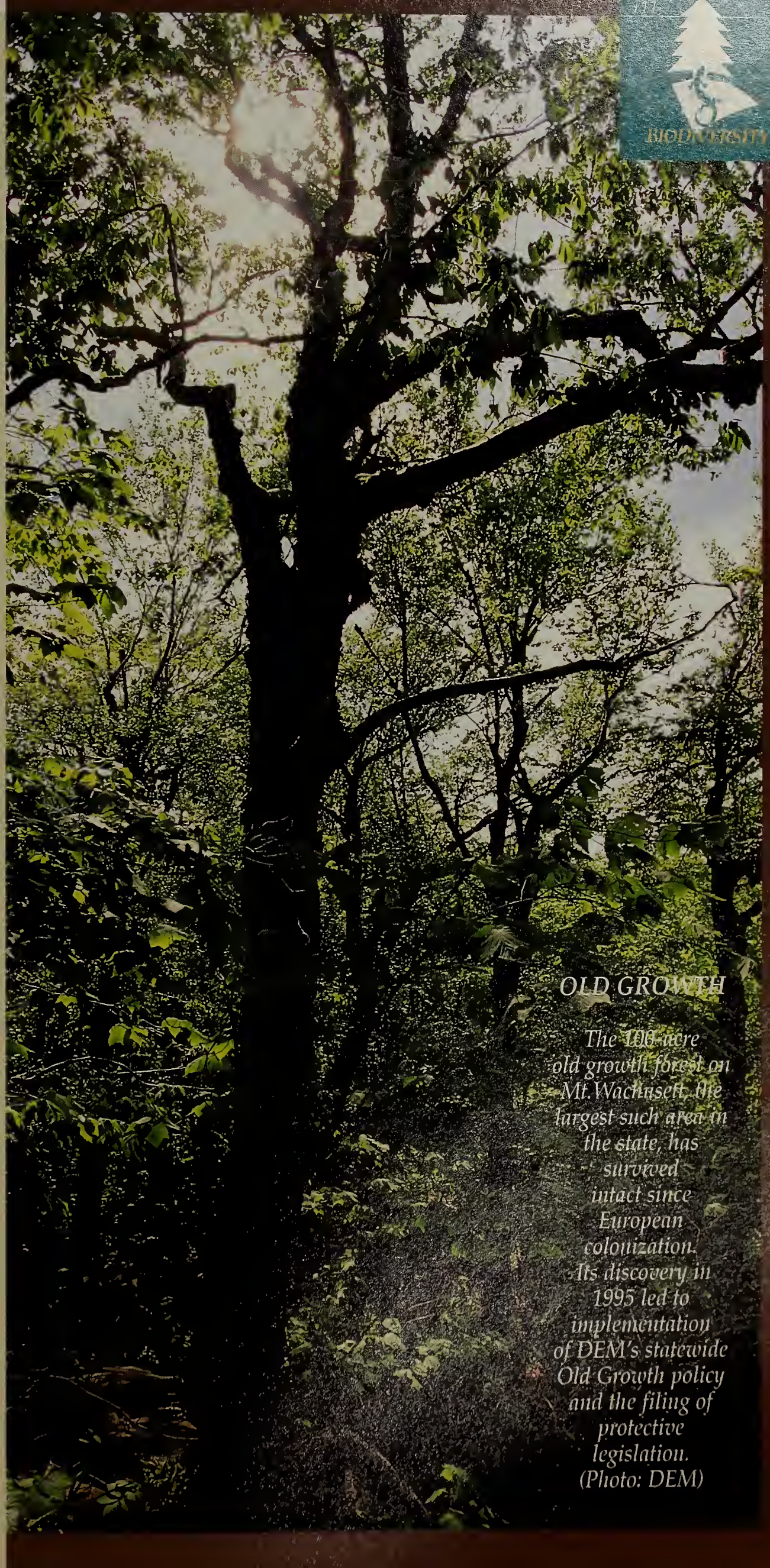
One particularly promsing example of biodiversity-based management is the purchase of conservation restrictions on private forest lands that provide long-term protection of the resource, while allowing sustainable timbering yields which can help support local rural economies. DFW is currently working with the New England Forestry Foundation on a prototype project.

Most forestland in Massachusetts is privately owned, in small parcels that average only 10 acres — half the size of an average parcel twenty years ago. This means that the turnover of forest lots is increasing, posing a greater challenge for sound management practices. Chapter 61 of the General Laws provides tax

abatements for land that is held for forestry purposes and managed according to an approved plan. If Chapter 61 lands are put on the market, the local city or town has a first option on purchasing the land. Approximately 250,000 acres have been put in Chapter 61 classification, but that is only 10% of the total private holdings statewide. Broader and more imaginative use of such tax incentives is called for.

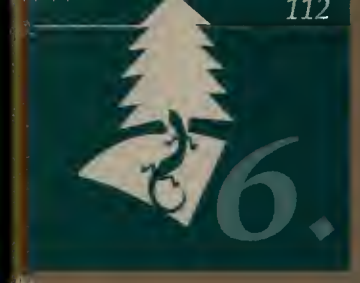
There are still a few areas of old growth forest in Massachusetts: uniquely valuable forests that have not been cut since European settlement began. Scientists have begun looking for these old growth forests in a more systematic way in recent years, and they have found more and more of them — sometimes in surprising places.

The state's largest known area of old growth is 100 acres of relatively low, wind-twisted birches, maples, oaks, and other trees at the top of Mount Wachusett, which was only recognized as old growth in 1995. The discovery prompted the Department of Environmental Management (DEM) to adopt a statewide policy to protect old growth forests on state lands. At Mount Wachusett itself, a proposed expansion of the existing ski area was redesigned to avoid the old growth and a surrounding buffer zone, and a new research and monitoring program has been put into place.



OLD GROWTH

The 100-acre old growth forest on Mt. Wachusett, the largest such area in the state, has survived intact since European colonization. Its discovery in 1995 led to implementation of DEM's statewide Old Growth policy and the filing of protective legislation. (Photo: DEM)



WHAT SHOULD BE DONE

By State Government

- Initiate the statewide biomapping project.
- Create a statewide system of bioreserves, starting with ecoregions most under stress.
- Establish an interagency committee to develop a strategy for the contro of invasive species, and to screen proposed releases of invertebrates for biological control.
- Through the Forest Vision Project, develop and implement a statewide biodiversity-based Forest Management Plan.
- Start a fund to purchase timberland conservation restrictions.
- Publish *A Citizen's Guide to Biological Diversity*.

By Local Government

- Improve community-based information on local biodiversity, such as establishment of a Local Species and Habitat Registry, to be maintained by the Conservation Commission or local non-profit, for use in local land use and open space planning and permitting.
- Work with the Council on Invasive Species to establish a program to control invasive species (plants, insects, and diseases) on municipal lands and throughout the community.

By Businesses

- Sponsor a Biodiversity Day in the community.
- Plant native vegetation, rather than lawns, around facilities.
- Design and develop facilities and projects that minimize habitat destruction and fragmentation.

By Citizens

- Participate in a statewide Biodiversity Day and ongoing inventories of local species.
- Help set up a Local Species and Habitat Registry in your community.
- Look for invasive species in your yard; plant native vegetation.
- Use the checkoff on your state tax form to contribute to the Natural Heritage and Endangered Species Program (it's tax deductible on your federal return).
- Avoid the use of pesticides by using native species of insect predators or biological/nontoxic controls such as insecticidal soaps and biodegradable insecticides.
- Comply with off-road vehicle regulations, to protect vegetated areas and nesting sites on beaches, trails, and other natural resource areas.
- Pick up litter such as six-pack rings, which can strangle wildlife, and plastic bags, which can choke wildlife if swallowed.

VANISHING GRASSLANDS

Katama sandplain Martha's Vineyard presents another of the eight key ural communities ntified by DFW lor biodiversity protection. his area was the habitat of the Heath Hen, indigenous game ird that became tinct in 1932. elopment and the pression of fires eaten the future these grasslands. (Photo: DFW)

7.

THE COASTAL ZONE

THE STATE OF OUR

BEACHES, HARBORS,

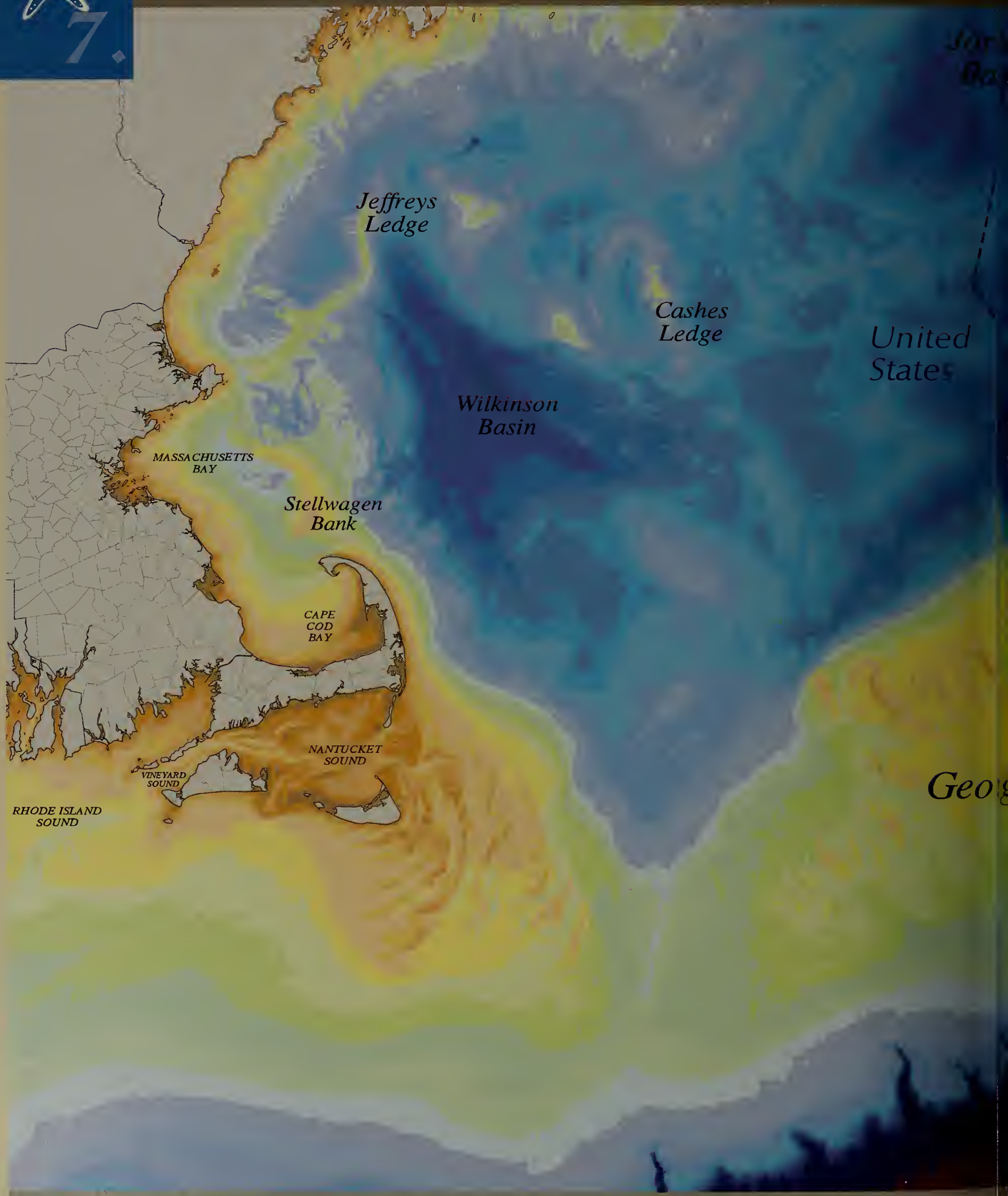
AND FISHERIES

The natural environment of the coastal zone
is as rich and highly varied as
that of any other part of the state.
The total length of the Massachusetts coast
is 1,974 miles — longer than the coast of California.
The total area of offshore state waters
is 2,727 square miles —
one third the size of the state's land area.
Over half of the state's population now lives within
50 miles of the coast, and summer vacationers and
tourists swell the numbers still further.

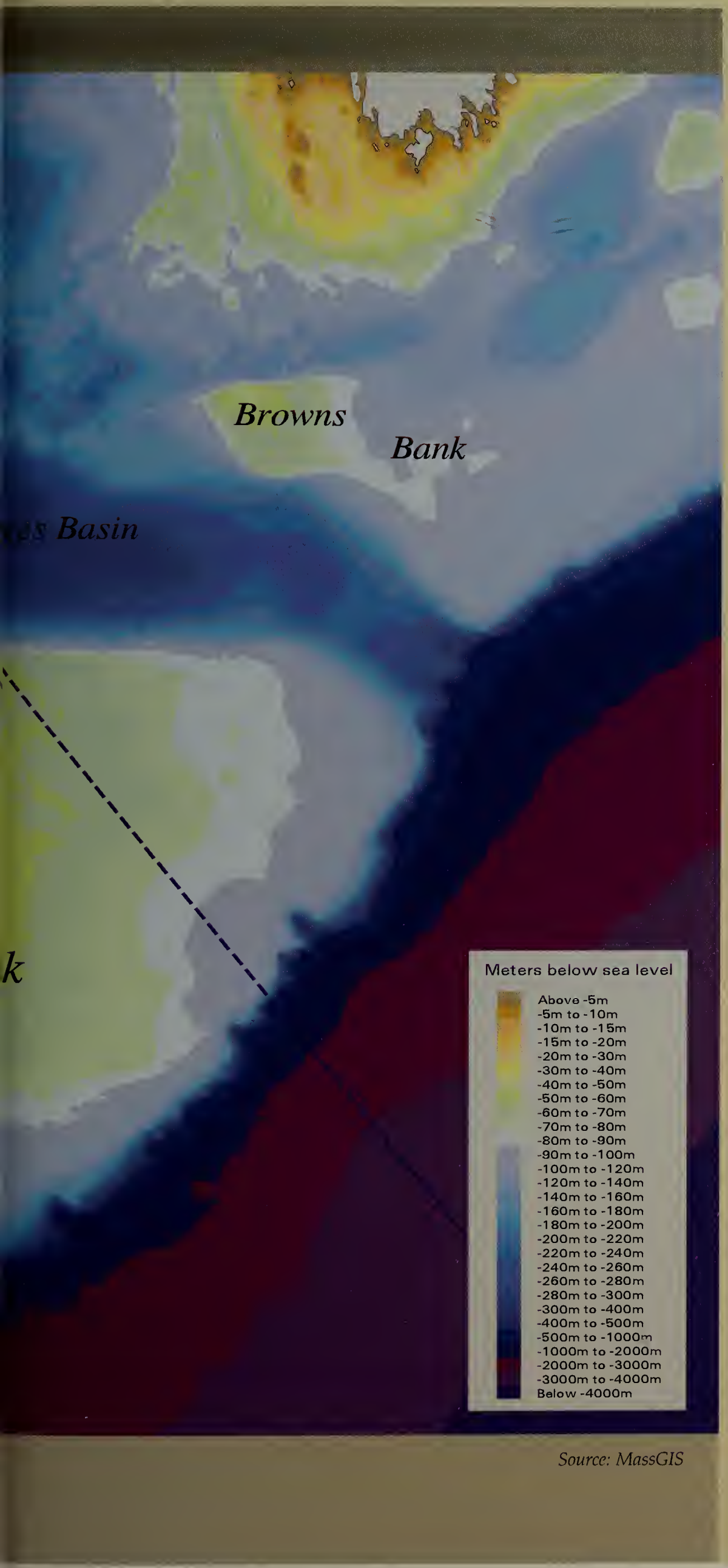
Because of the value and fragility
of the coastal resources,
some of the most pressing environmental issues
come into particularly sharp focus within
the coastal zone:
Saltwater marshes and estuaries,
biologically the richest natural
communities found in the state, are particularly
vulnerable to contaminated stormwater runoff
and other sources of water pollution.
Barrier beaches,
which provide wildlife habitat and bulwarks against
storms, are also the state's most popular and
heavily used open spaces.
Planning for waterfront activities
in our coastal ports must protect the needs of
fishing, shipping, and other waterfront industries
against commercial and residential
development pressures, and ensure public access
to attractive open spaces along the shore.
Management of the offshore fisheries
of Georges Bank and other areas
requires restoring the biodiversity of these
ecosystems, and limiting extractive use to
levels that can be sustained over the long term.

7.

MAP 7.1: THE COASTAL WATERS



The coastal zone extends from the 1,900-mile-long coastline, with its estuaries, barrier beaches, and headlands, to the rich fishing grounds of Stellwagen and Georges Banks, within the 200-mile limit of federal waters.



Source: MassGIS

OUR COASTAL RESOURCES

Two different kinds of ecosystem characterize the coast. The glaciers left most of the Massachusetts shore soft and sandy. Waves and currents constantly shape and reshape barrier beaches and their dunes, which are vegetated only by beach grass and low shrubs and trees. On the rocky headlands of Cape Ann, and wherever docks and piers have created hard surfaces, one finds a very different set of natural communities, from the kelp, starfish, and periwinkles that cling to the rocks, to the fish and diving ducks that feed on smaller creatures.

Behind the barrier beaches one finds estuaries with underwater eelgrass beds, and mud flats and spartina marshes in the intertidal zone. These sheltered areas are the key to the richness of marine and coastal life. Fish, shellfish, and crustaceans spawn here, as do the birds and animals that feed on them.

The flexible, self-repairing natural defenses of coastal barrier beaches and dunes protect low-lying coastal areas against the ocean waves of hurricanes and nor'easters. These defenses work best when shaped by natural forces. Attempts to armor coastal banks with stone riprap, or to stop beach erosion by building jetties and breakwaters, often result in greater erosion on neighboring beaches. In addition, the mapping of long-term shoreline changes since the mid-nineteenth century shows

7.

an inexorable trend of erosion in many areas, particularly the outer Cape and the Islands.

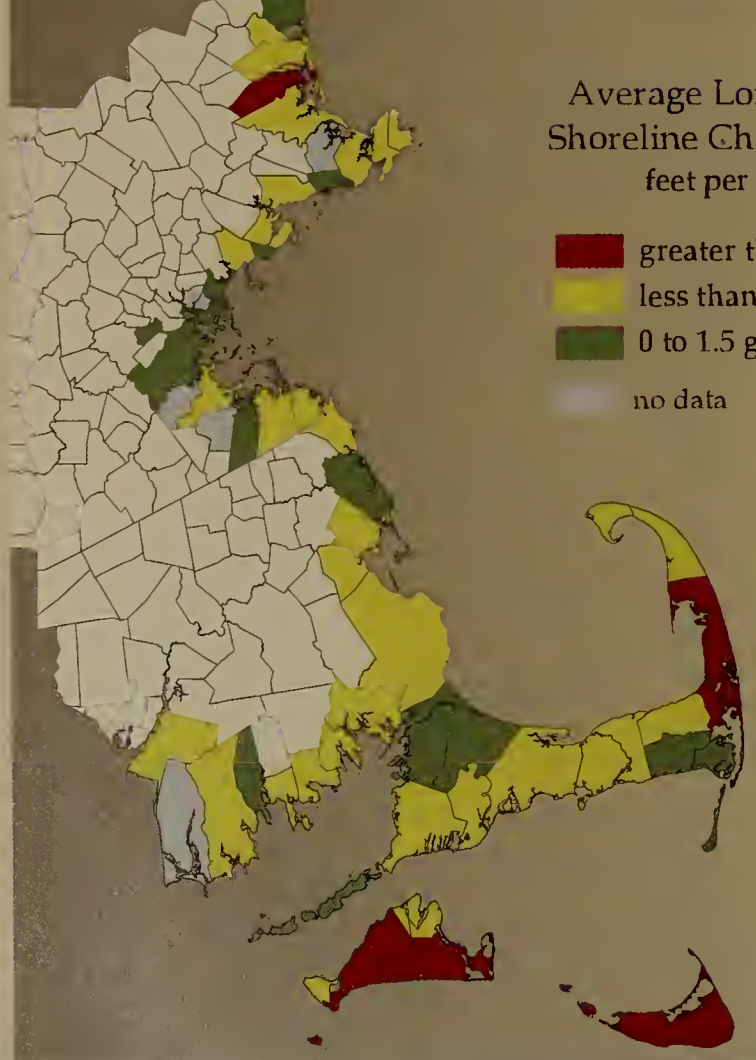
By law, the state's coastal zone starts 100 feet inland of the first coastal street or railroad, and it extends three miles offshore. But the interplay between land and sea extends much farther inland, and much farther out to sea.

Because all the rivers and streams in the eastern third of the state run to the coast, the pollutants and excess nutrients that they carry greatly affect the quality and health

THE FORCE OF COASTAL EROSION

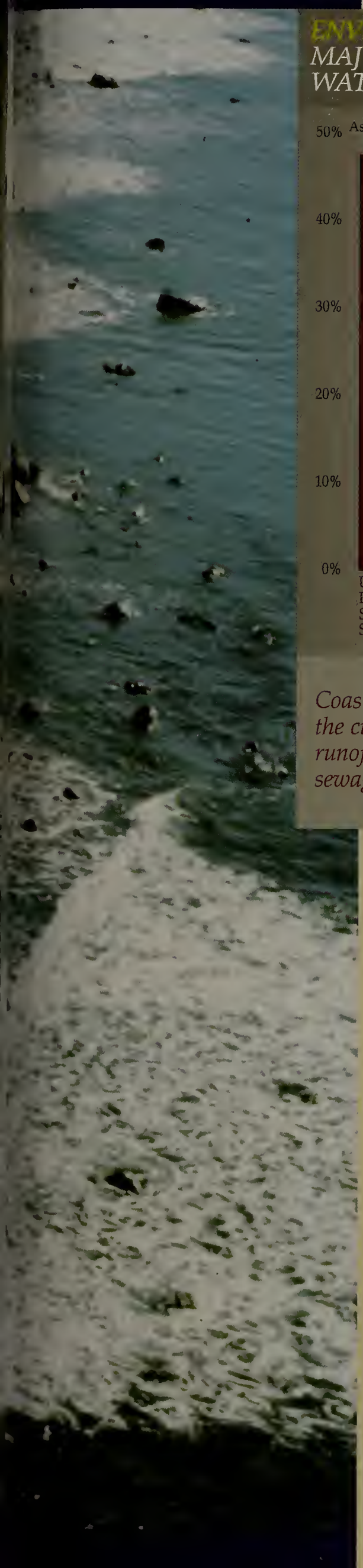
Coastal erosion, shown here on the south coast of Martha's Vineyard, poses an ongoing challenge. Construction of stone groins, seawalls and jetties often results in greater erosion on neighboring beaches. Current policy favors beach nourishment and other "soft" solutions. (Photo: MCZM)

MAP 7.2: SHORELINE EROSION AND

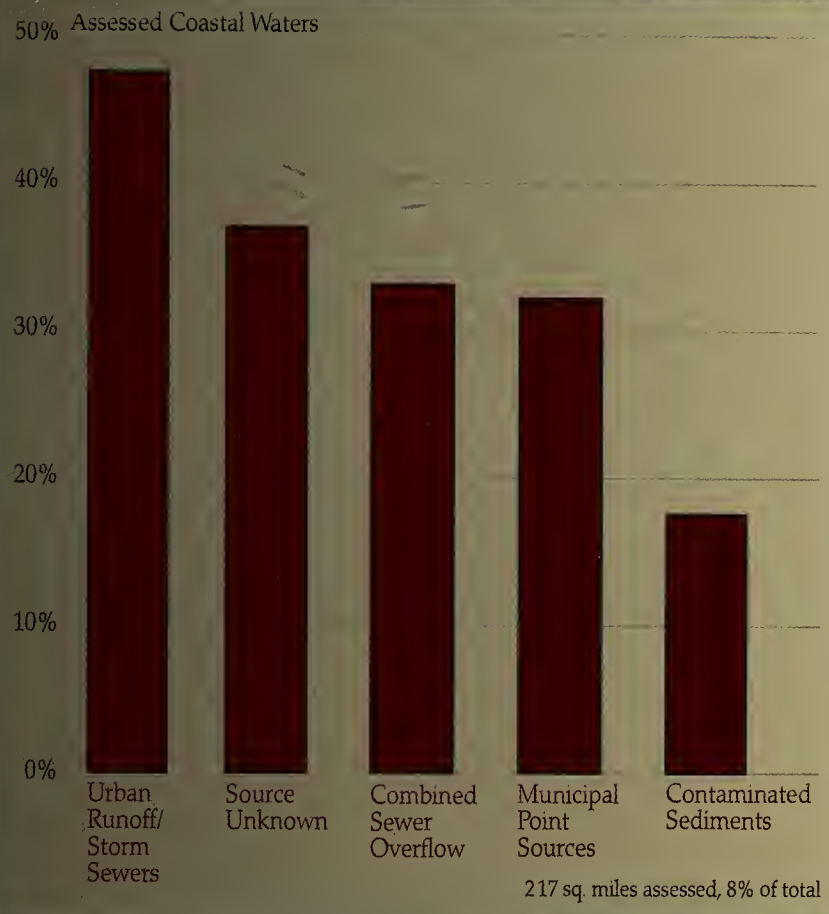


Source: MCZM

Long-term shoreline changes since the nineteenth century (calculated here on a community-wide basis) show an inexorable trend of erosion in many areas.



ENVIRONMENTAL INDICATOR 7.1: MAJOR SOURCES OF COASTAL WATER POLLUTION



Source: DEP, 1998 305B Report

Coastal estuaries are particularly vulnerable to the cumulative stresses of polluted stormwater runoff, combined sewer overflows (CSOs), and sewage treatment plants.

of coastal estuaries. Shallow marine estuaries like Boston Harbor are particularly vulnerable to nutrient overloading and pollutant-laden sediments. Urban runoff and storm sewers affect the water quality of almost half of all tested coastal waters. Combined sewer overflows (CSOs) and municipal point sources each affect one-third of all waters tested. Contaminated sediments pose a particular challenge in Boston and other active ports, where shipping channels require regular dredging. The U.S. Army Corps of Engineers is undertaking a pilot project to cap such sediments in place.

For fishermen, the coastal zone includes the full 200-mile-wide area regulated by the federal government. This zone includes Stellwagen Bank, between Cape Ann and Provincetown, and most of Georges Bank, an underwater extension of Cape Cod's glacial formation. Georges Bank is a broad, shallow area, approximately 180 miles by 90 miles, covered by less than 300 feet of water, which supports some of the richest fishing grounds in the world. Here, in the cold waters of the Labrador Current, immense blooms of plankton support spawning scallops and groundfish, including cod, haddock, and flounder.

The state's system of protected spaces extends into the coastal waters. The majority of Massachusetts state waters, including all of Cape Cod Bay, are designated as Ocean Sanctuaries. Within the sanctuaries, state law forbids any exploitation, development, or other activity that would seriously damage the ecology or the appearance of the ocean and its seabed. The federal government has designated Stellwagen Bank as a National Marine Sanctuary. The rich fishing grounds of Georges Bank are under a federally imposed moratorium on oil and gas drilling until the year 2012.

7.

THE LIVING SALT MARSH

Saltwater spartina marshes, such as the Great Marsh on the North Shore, can support the traditional harvesting of salt hay without harm to the natural ecosystem. (Photo: MCZM)

7.

PRESSURES OF COASTAL RECREATION

Half of the Massachusetts population now lives within 50 miles of the coast. The demand for coastal recreation imposes severe strains on fragile resources. (Photo: MCZM)

PUBLIC ACCESS TO THE WATERFRONT

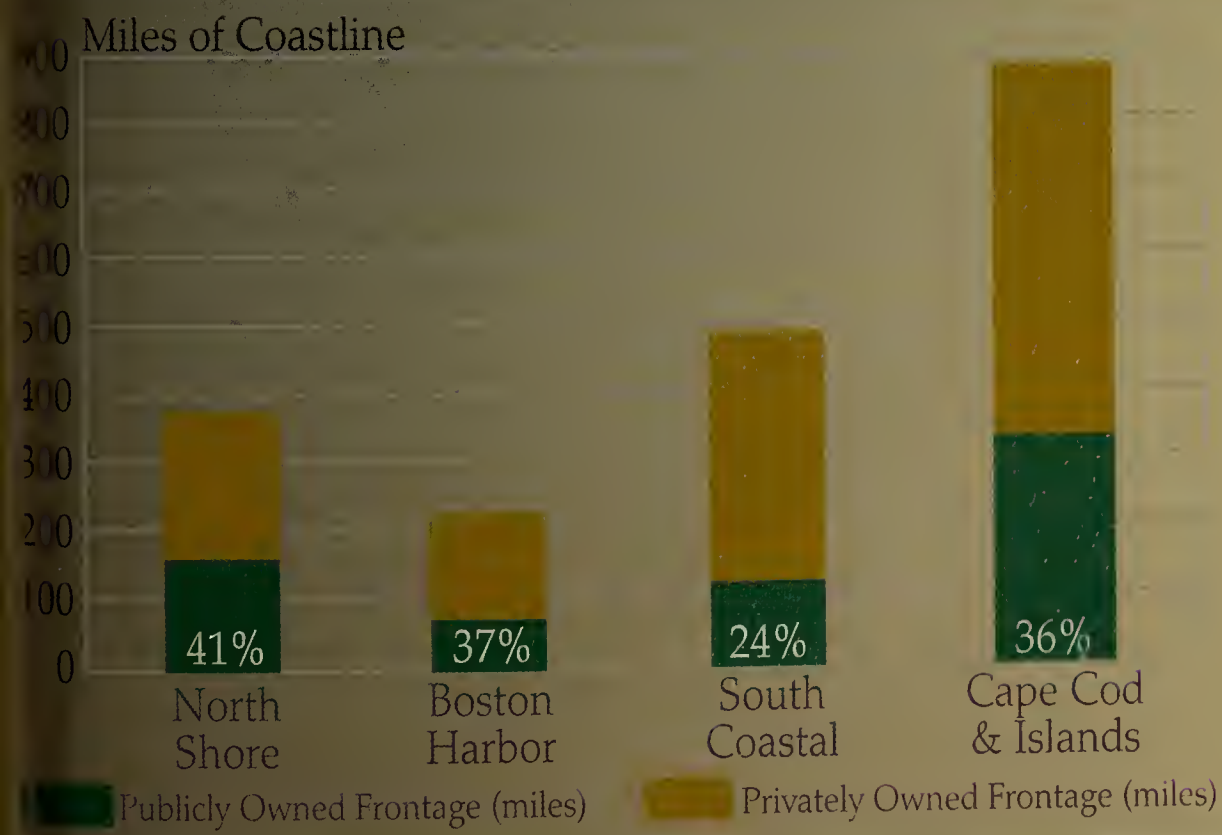
Most of the fast-growing areas of the state are located in the coastal zone. As the mapping of population changes shows (see Map 2.2), the North Shore, the South Shore, Cape Cod, and the Islands have all seen rapid growth and development pressures in recent decades — a trend that is likely to continue.

Access to the coastline is one of the state's great attractions for residents and visitors. A recent poll showed that of all the state's open space resources, coastal beaches are the most widely and frequently used (see Environmental Indicator 8.2). The beaches of Cape Cod and the Islands are key to their tourist economy.

Public ownership of the coastline is limited, however. A total of only 660 miles, one-third of the total, is publicly owned. In some regions the percentage is far lower. State agencies and private nonprofit land trusts are trying to increase public access by buying land or conservation easements, reclaiming historic public rights-of-way, and offering tax incentives to private owners. In the last two years alone the state has protected 658 acres of coastal open space. However, rising property values and encroaching development make the task more difficult.

Chapter 91 of the General Laws embodies a legal principle dating back to the Magna Carta and ancient Rome. The state owns the ocean and the lands washed by its tides – not to dispose of freely, but rather to manage responsibly, acting as a trustee for the rights of the public at large. In Massachusetts these broad "public trust" rights extend to the low tide

ENVIRONMENTAL INDICATOR 7.2:
PUBLIC OWNERSHIP OF THE COAST



Source: MCZM

Only 660 miles, one-third of the total coastline, is accessible to the public – and far less in certain regions.

7.

mark. The zone between high and low tides is owned by the abutting private landowner, but it is subject to a public right of access for fishing, hunting, and boating. Public trust rights also apply to former tidelands even after they have been filled.

To protect these public trust rights on behalf of all Massachusetts citizens, DEP regulations set standards for new waterfront developments in places such as Boston Harbor, where the shore-

MAP 7.3:
CHAPTER 91 AND THE FILLING OF BOSTON HARBOR

Source: DEP, MCZM

Much of Boston Harbor has been filled since colonial times, a process authorized under state licenses. New waterfront developments are subject to the "public trust" requirements of Chapter 91, and must provide open space and facilities that are lively and publicly accessible.

line is largely man-made. New projects must incorporate publicly accessible walkways and parks, so that the public can continue to use and enjoy these irreplaceable resources. The regulations are particularly protective of the needs of fishing, shipping, and other waterfront industries. These water-dependent businesses are particularly vulnerable to displacement by commercial or residential development. Once a pier, a storage yard, or a truck route has been lost from the working port, it is virtually impossible to restore those uses in the future.

Through the development of Municipal Harbor Plans, cities and towns may modify the statewide regulatory standards to address local conditions, so long as the public's access rights and the needs of working ports are protected. To date, six Harbor Plans have been approved by EOEA and four more are in preparation.

LIVELY PUBLIC WATER-FRONTS
Christopher Columbus Park, between Boston's North End and the Long Wharf, is a key element in the city's Harborwalk system, which will ultimately extend the full length of the waterfront. (Photo: Boston Redevelopment Authority/Kairos Shen)

7.

MARINE FISHERIES AT THE CROSSROADS

The Commonwealth's marine fisheries are at a crossroads. Commercial fishermen and fishery managers face major challenges as they try to rebuild overfished stocks and ensure that harvest levels are sustainable. This will require a cooperative attitude among all the stakeholders, one that supports more stringent regulations and reduced catches over the short term. Otherwise, there is a real risk of economic and ecological collapse.

The offshore fisheries have historically been one of the state's most productive natural resources. Although total catches are now only one-third the level seen in the late 1940s, fishing remains a major industry in Massachusetts, supporting 20,000 jobs. The state is home to one of the largest fishing fleets in the nation, with vessels ranging in size from offshore trawlers capable of trips to Georges Bank to single-handed skiffs using handlines, pots, or nets. The largest fleets can be seen in New Bedford, Gloucester, and Boston. In 1998, Massachusetts ranked fourth nationwide in the value of catches landed in its ports, and New Bedford was second among all ports. For individual species, Massachusetts was first in harvesting sea scallops and second in lobsters.

Overfishing is not a new problem — it has occurred with each advance in fishing technology over the past century. Fish stocks fell when gillnetting was introduced to local fisheries in the late 1800s, replacing longline hook fisheries, and again when trawling (or dragging) became widespread after 1900. During the 1960s, foreign factory trawlers exploited many valuable species. In response, Congress excluded all foreign vessels within 200 miles of shore through the 1976 Magnuson Act. However, reserving the coastal fisheries for American vessels did not halt overfishing. The Massachusetts fishing fleet grew dramatically during the 1980s, fueled by government financing programs. The increased fishing resulted in continued declines in cod, haddock, flounder, and other commercially important species through the 1990s.

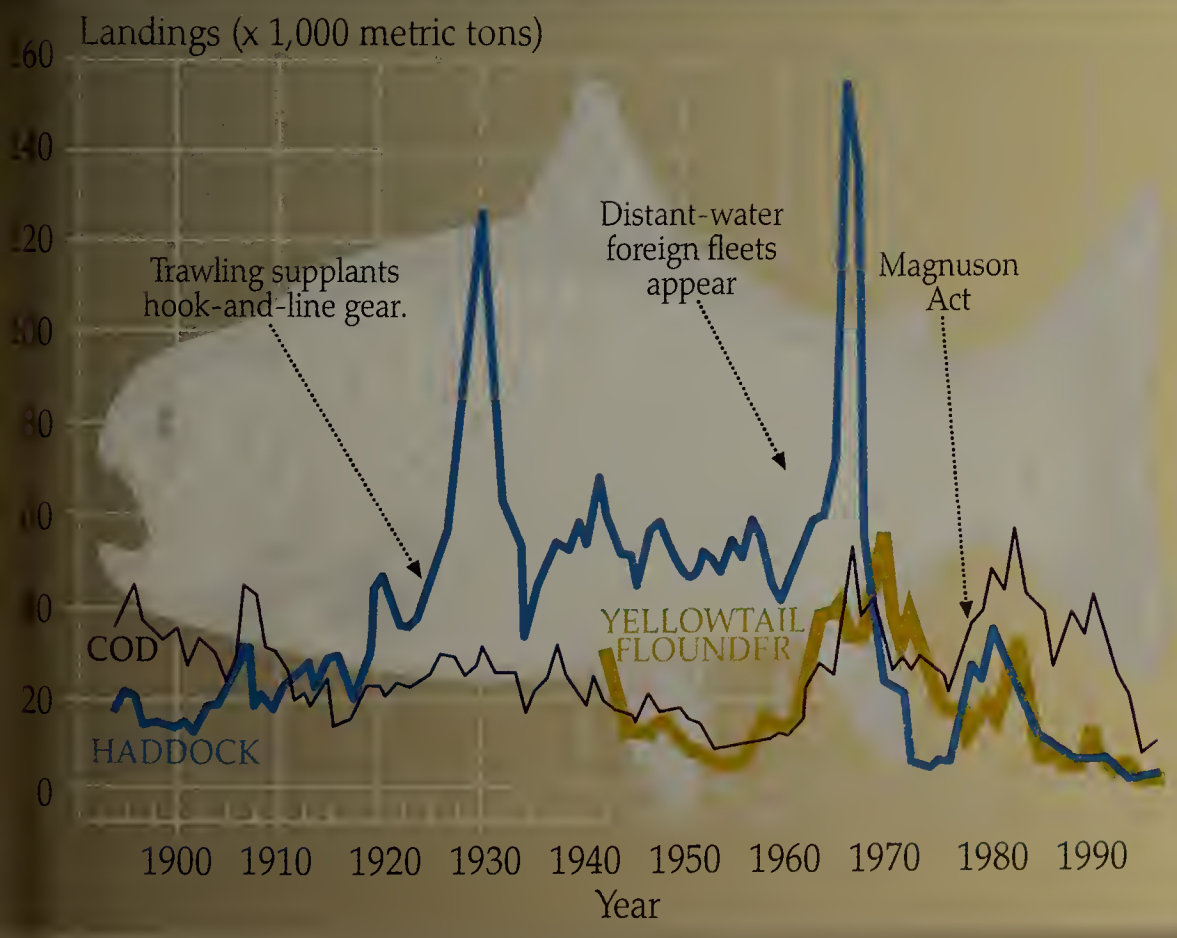
Habitat loss and degradation have also reduced the "carrying capacity" of marine ecosystems – the maximum number and abundance of different species that the resource can support. Some scientists and fishermen are asking whether commonly used fishing gear, such as otter trawls and sea scallop dredges, are unduly disturbing the ocean bottom. Habitat loss is reducing the carrying capacity of ecosystems for some nearshore species that are in decline, such as winter flounder. Scientists also suspect that pollution in salt ponds and estuaries in southern Massachusetts has caused the decline in bay scallops.

Today, fisheries managers struggle to rebuild fish stocks while sustaining the existing infrastructure and investments.

FISHING INDUSTRY STRUGGLES FOR SURVIVAL

The pressures on the fishing industry caused by depleted offshore stocks have severely affected the economies of New Bedford, Gloucester, and other seaports. (Photo: DMF)

ENVIRONMENTAL INDICATOR 7.3: GROUNDFISH CATCHES ON GEORGES BANK SINCE 1900



Source: National Oceanographic and Atmospheric Administration (NOAA), Our Living Oceans

Overfishing has occurred with each advance in fishing technology, from gillnetting and trawling to the over-expansion of the New England fleet during the 1980s.

Gone are the days of low-interest loans and marketing promotions that encouraged consumers to eat underutilized species. Even those species once promoted as "trash" fish, such as dogfish, skates, monkfish, hake, and squid, have been exploited commercially and now need strict conservation measures.

More and more, fishermen are realizing they will have to adjust their traditional outlook on fishing; instead of relying on short-term windfalls, they will have to make do with fewer fish. New management plans require fishermen to leave between two-thirds and three-quarters of the available fish in the water, so that populations can rebuild themselves.

Prescriptions for recovery are often extremely complex. Fishermen are frustrated by the multitude of management plans that often address single species. Fishing gear (nets, hooks, and traps) in use today has not evolved as quickly as the complex regulations. State and federal scientists are developing, testing, and promoting new fishing gear to reduce fishermen's by-catch and discard of juvenile fish such as flounders and other groundfish, and to reduce impacts of towed nets on the seafloor.

There are some signs of hope. A recent report issued by the federal National Marine Fisheries Service indicated that New England groundfish stocks are still overfished and in need of rebuilding — especially cod in the Gulf of Maine and Georges Bank and yellowtail flounder in southern

New England. However, some stocks, including bluefin tuna, summer flounder, haddock, tautog, and weakfish, have begun to respond to management controls, including offshore closures of productive fishing grounds, strict limits on each vessel's allowable fishing days, and limits on catch of some species. State and federal fishery scientists hope the newly enacted Gulf of Maine cod closures will reverse the decline of this important stock. Once restored this stock could yield about 25 million pounds annually — far above the approximately 3 million pounds allowed in 1999.

MAP 7.4: CLOSED OFFSHORE FISHING GROUNDS

Source: NOAA, Our Living Oceans

The closure of offshore fishing grounds is necessary so that overfished stocks can rebuild to levels at which species populations will sustain themselves, even after fishing resumes.

In contrast to the complex management challenges presented by offshore fish stocks, the health of the Commonwealth's shellfisheries is improving. Stocks of quahogs, oysters, soft-shelled clams and even bay scallops have rebounded in several areas.

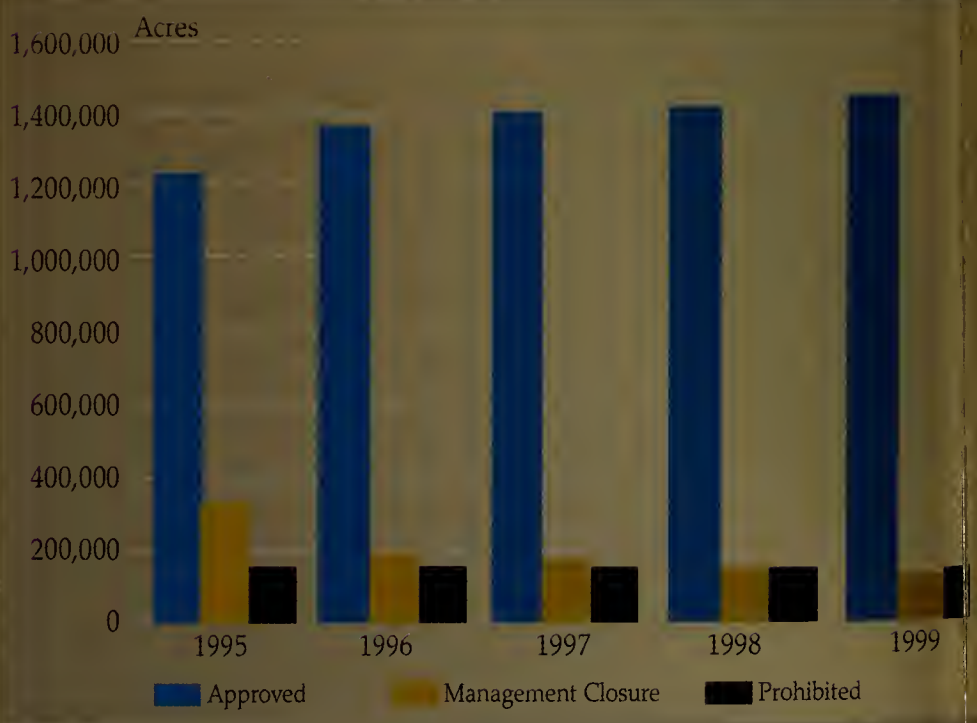
Coastal water quality, as measured by the classification of shellfish-growing areas by DMF's Shellfish Sanitation Program, is showing a positive trend. Since 1995 over 260,000 acres of shellfish beds have been upgraded — 50,000 acres in 1998 alone — due to the cumulative effects of water pollution enforcement and cleanup efforts, and DMF surveys of previously unclassified beds.

Shellfish aquaculture is also increasing at a steady rate. Aquaculture operations are licensed by the cities and towns and supported by regional centers. DMF surveyed and approved 20 new sites in 1998.

Recreational Fishing

Freshwater and saltwater fishing is one of our most popular outdoor sports. Over 700,000 anglers fish in Massachusetts, spending over $500 million annually. DFW stocks up to 700,000 fish each year in the state's waterbodies.

ENVIRONMENTAL INDICATOR 7.4: STATUS OF SHELLFISH BEDS SINCE 1995



Source: D

Over 260,000 acres of shellfish beds have been upgraded since 1995, due to cleaner coastal waters and DMF survey of unclassified beds.

RETIRED TEACHER NOW TEACHES BY EXAMPLE

After a 33-year teaching career, you might think Len Gonsalves would want to sit back and take it easy. But since being appointed the Executive Director of the Buzzards Bay Action Committee (BBAC) just over two years ago, Gonsalves has been doing anything but taking it easy.

The BBAC works to mitigate sources of pollution in the bay that, over the years, have damaged shellfish beds, water quality, and fish populations.

"I grew up in an environment that was nature- and farm-oriented, so I've had that inclination throughout my life," he said. "I was convinced in 1990 that we had to do something to protect Buzzards Bay, so I signed on to the compact that created the BBAC."

When he was appointed, the BBAC was in a transition, with no money for new talent. So Gonsalves, also a Dartmouth selectman, offered to take the job as a volunteer.

Gonsalves and the BBAC work on many issues: pushing legislation to deal with marine fueling, lobbying the EPA to declare the bay a "No Discharge Area" for boat sewage, and keeping contaminated boat bilge discharges out of the bay, to name a few. Most recently, Gonsalves helped the BBAC win a grant to distribute oil-absorbent bilge socks to 8,000 boaters free of charge.

Last year he won a Visionary Award from the Gulf of Maine Council for his efforts. "I signed on, but I wasn't part of the initial down-in-the-trenches fight to have this happen," he said of the overall efforts to keep the bay pollution-free. "The vision comes from the [BBAC] board. I was very flattered by the award. It makes me feel it's been a good match."

Now the BBAC has embarked upon environmental education projects. It is working with the Southeastern Massachusetts Environmental Education Alliance to strengthen environmental science curriculum offerings in area schools. The BBAC is also using the Dockside Program to bring school children to the Department of Environmental Management's tall ship Ernestina, where they learn about the bay.

"Educate young people on the value of the bay as a resource, and they'll be in a much better position as adults," Gonsalves said, still sounding like a teacher. "We need a voting public that understands these issues."

WHALE WATCHING BECOMES A THRIVING INDUSTRY

Nearly one million passengers a year embark on whale-watching trips from Massachusetts harbors. Care must be exercised so that boats do not strike whales or affect their behavior. (Photo: DMF)

WHALES AND WHALE WATCHERS

Massachusetts waters provide habitat for more than 30 species of whales, porpoises, seals, and sea turtles. Of these species, all of the turtles and six of the large whale species are currently listed as endangered by the federal or state government.

Whales are generally found off the coast only at certain times of year. During the late winter and early spring, northern right whales migrate to Cape Cod Bay and the Great South Channel between Nantucket and Georges Bank to feed on the abundant microorganisms. Humpbacks, minkes, and fin whales are commonly found during the summer on Stellwagen Bank, where they feed on herring, sand eels, and mackerel.

Although federal law now outlaws the hunting of whales, through the early twentieth century whaling played an important role in Massachusetts history. Native Americans living along the coast used to catch whales close to shore from large canoes. After the European settlement, larger ships allowed the whalers to hunt their prey farther and farther offshore. Whaling ships from Nantucket, New Bedford, and other Massachusetts ports sailed on multi-year voyages to Greenland, the Azores, the South Atlantic, and eventually the South Pacific. Whales were used for food, oil (produced by boiling blubber), and bone. In 1857, New Bedford was the home port for more than 300 whaling ships, employing 10,000 men. The replacement of whale oil lamps by petroleum and kerosene, coupled with the decreasing size of the whale populations, eventually led to the decline of the Massachusetts fleet.

In the 1970s international agreements were signed to protect whales. Aside from the right whale, most of the whale populations found in Massachusetts waters are recovering or have already stabilized. Today, the principal human threats to whales in local waters are pollution, ship strikes, and entanglement with fishing gear. Certain types of whales also die from occasional mass strandings on local beaches. Scientists are baffled by the strandings, although disease or inner ear infections offer possible explanations.

Protection of the right whale poses a particular challenge. Whalers termed this species the "right whale to kill" because of its thick blubber, its slow movements, and the way its body floated after it was killed. Past hunting drove the right whale dangerously close to extinction; only about 300 individuals survive in the North Atlantic. Federal and state agencies, researchers, fishermen, and conservationists are all working to develop strategies that will protect this species.

Starting in the 1970s, public interest in these fascinating animals has led to a thriving whale watching industry. With its close proximity to Stellwagen Bank, Massachusetts has the largest whale-watch fleet on the East Coast, contributing an estimated $100 million to the coastal economies. In 1996 more than 860,000 passengers embarked on whale watching trips from Massachusetts harbors.

Whale watching has educated many people about the need to protect and better understand these animals and the ocean where they live. Whale-watch boats have also provided an excellent opportunity for researchers to learn more about whale populations and behavior. Increasingly, however, there is some concern that the boats may be affecting the behavior of the whales, or that a boat may accidentally strike a whale. New regulations are under consideration to address these concerns.

WHAT SHOULD BE DONE

By State Government	• Establish the Coastal Institute to provide ongoing environmental training to public and private sector coastal managers. • Support local and regional efforts to minimize nonpoint source water pollution and coastal debris. • Recommend the designation of Buzzards Bay as a No Discharge Area (NDA) for boaters, and support efforts to establish NDAs in other coastal waters. • Promote coastal access through land acquisition, protection of historic rights of way, and incentives to donate coastal land for public access. • Develop an inventory and guidebooks for the public on coastal access sites along the coast. • Promote a fisheries management approach for our offshore and nearshore fisheries, grounded in economic, biological conservation, and ecosystem protection considerations. • Support MCZM's Shellfish Clean Waters Initiative to open shellfish beds in cities and towns.
By Local Government	• Work closely with EOEA to identify local coastal access opportunities. • Avoid the "gentrification" of the waterfront by maintaining infrastructure for fishing and maritime industries. • Work with MCZM to develop and implement a Municipal Harbor Plan and pursue other coastal planning activities. • Encourage local shellfish aquaculture and municipal propagation efforts.
By Businesses	• Design and develop new facilities and projects to minimize stormwater runoff and other nonpoint source pollution. • Work with MCZM, DEP and local governments to maximize public waterfront access opportunities.
By Citizens	• Comply with off-road vehicle regulations to protect vegetated areas and nesting sites on beaches, trails, and other natural resource areas. • Participate in CoastSweep beach clean-up programs. • Research and document historic rights-of-way for beach access in your town as a means of reestablishing public rights to those areas. • Support local fishermen and aquaculturists by buying local fish and shellfish.

8.

LAND PROTECTION

THE STATE

OF OUR

OPEN SPACES

Massachusetts citizens enjoy the use of
a large and highly varied open space system.
Over one million acres
— one-fifth of the total area of the state —
are permanently protected for
conservation and recreation.
Open spaces serve a wide range of purposes,
from ballfields and public gathering places,
to the protection of wildlife habitat, scenic beauty,
historic sites, water supplies, and farmlands.
The statewide system combines ownership
by government and private nonprofits,
private lands that are legally restricted to
conservation purposes, ocean sanctuaries,
and large resources designated as
Areas of Critical Environmental Concern.

In the last ten years alone, Massachusetts
has protected 100,000 acres of new open space.
Governor Cellucci has set a goal of
protecting a further 200,000 acres by 2010.

But open spaces remain under siege
from the forces of sprawl development.
If current land development rates continue,
the total statewide area of developed land
is likely to exceed the area of protected
open space before the end of this decade.

To preserve the character of
the Massachusetts landscape,
we need to target key open space needs:
protecting watersheds and biodiversity,
preserving historic landscapes
and working farms and forests, and expanding
open space access for city dwellers.
A statewide network of greenways
should connect our public open spaces
into a single, interconnected system.

OUR PUBLIC LANDS: PAST AND PRESENT

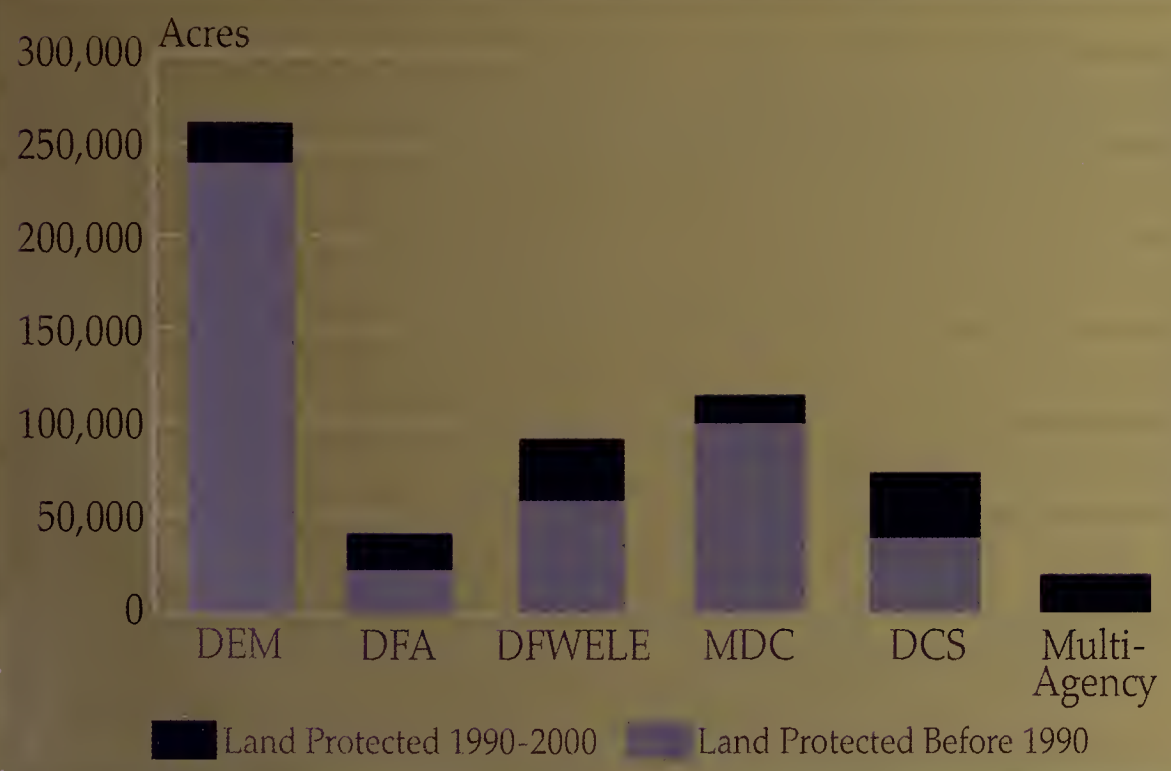
Most of the permanently protected open space in Massachusetts is publicly owned: nearly one million acres, about one-fifth of the state's total area. Over 500,000 acres are owned by state agencies — chiefly the Department of Environmental Management (DEM), the Metropolitan District Commission (MDC), and the Division of Fisheries and Wildlife (DFW).

Massachusetts has been a leader in the creation of public open space throughout its history. The town common, which served as a focal point for seventeenth-century town layouts, provided the genesis for our modern public parks. In 1871, Frederick Law Olmsted, the founder of the landscape architecture profession in America, came to Boston to create what is now known as the "Emerald Necklace" a seven-mile-long system of parks and parkways that links downtown Boston to its outlying residential areas, providing public open space transportation access, and the environmental restoration of degraded streams and wetlands. In 1893 the legislature formed the Metropolitan Parks Commission, forerunner of today's MDC, to acquire the nation's first regional open space system. By 1900 the public acquisition of Mount Greylock Mount Tom, and Mount Wachusett for conservation purposes had laid the foundations for our present state park system.

OPEN SPACE FOR WILDLIFE

Our open space system runs the gamut from urban parks to wilderness areas, such as Tully Lake in the Otter River State Forest (Photo: DEM/Gene Peach)

ENVIRONMENTAL INDICATOR 8.1: STATE OPEN SPACE OWNERSHIP AND GAINS



Source: MassGIS

In the past ten years the state has protected 100,000 acres of new open space. Governor Cellucci has set a goal of protecting an additional 200,000 acres by 2010.

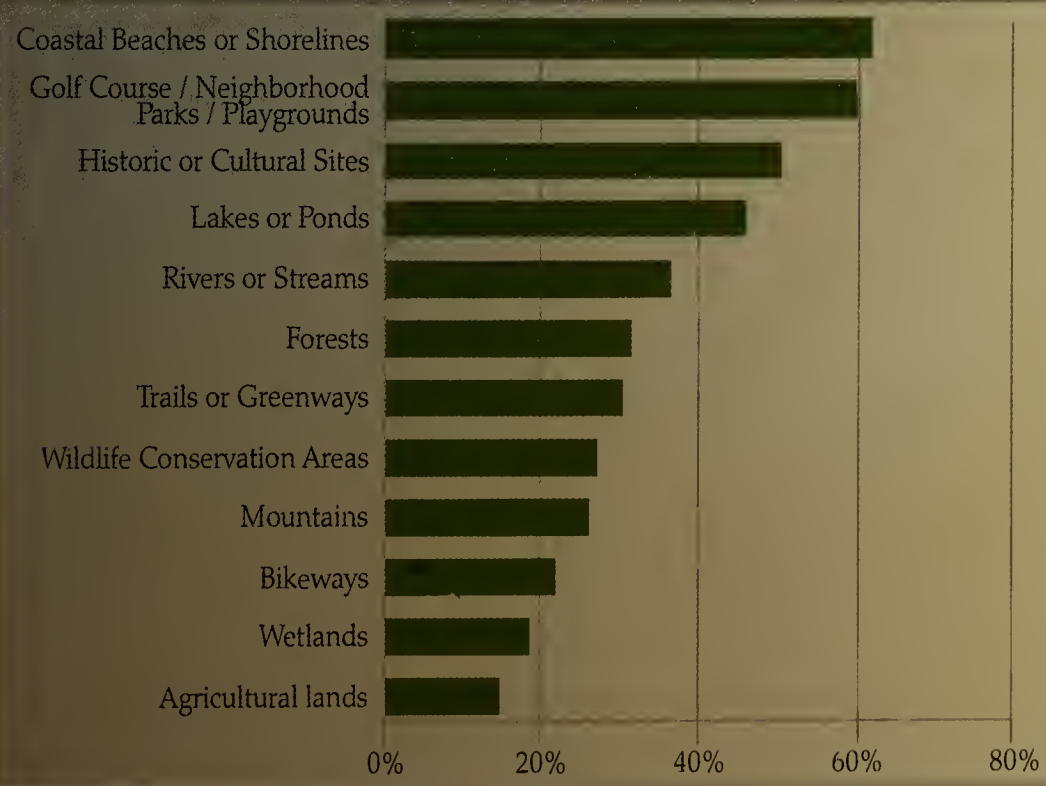
Several individual sites are greater than 10,000 acres, including the MDC's Quabbin Reservation, DEM's October Mountain State Forest, Myles Standish State Forest, and Mt. Greylock State Reservation, and the newly created Upper Cape Water Supply Reserve, to be managed by an environmental commission comprising DEM, MDC, and DFW.

Municipalities are the second largest owners of open spaces in the state: more than 325,000 acres in over 7,000 individual sites. Municipal lands range from parks and playgrounds to land held for water supply or conservation purposes. The federal government holds 62,000 acres of open space, half of this within the Cape Cod National Seashore.

The Commonwealth's open space system runs the gamut from urban parks like the Charles River Esplanade in Boston, to historic sites such as Plymouth Rock, to mountainous landscapes like Mount Greylock in the Berkshires. DEM directly manages more than 278,000 acres of land, the MDC another 130,000 acres, and DFW a total of 100,000 acres.

Each of these state agencies has made significant new acquisitions during the last few years. Sportsmen have enabled DFW to purchase 20,000 acres of open spaces over the last decade, funded by the $5 Land Stamp on all hunting and fishing licenses.

ENVIRONMENTAL INDICATOR 8.2:
OPEN SPACES VISITED WITHIN 12-MONTH PERIOD



Source: ©1995, Chadwick, Martin, Bailey, Inc., for DEM, State Comprehensive Outdoor Recreation Plan (SCORP)

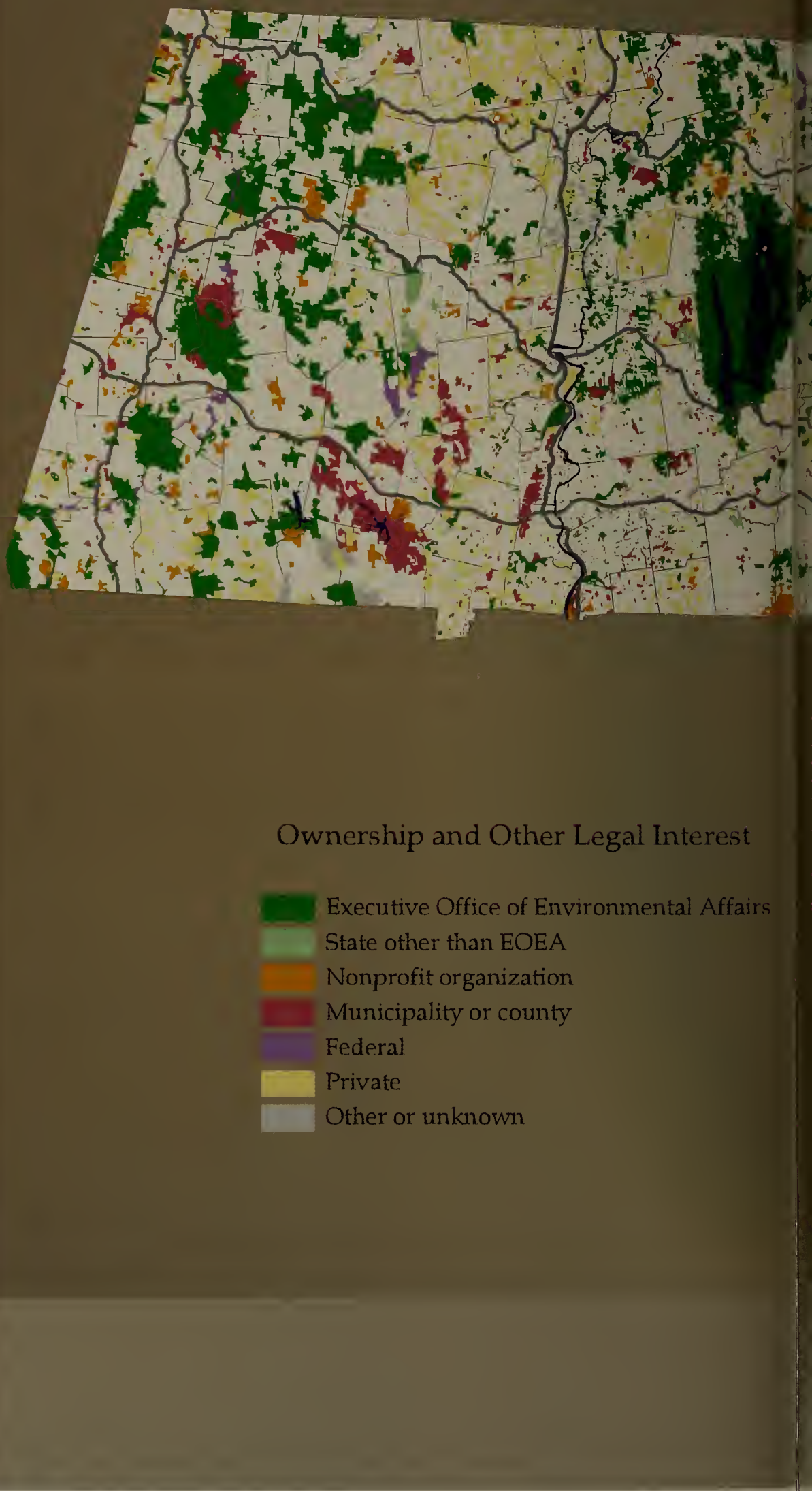
A recent survey shows that each open space category, from beaches to historic sites, mountains, and wetlands, is visited by significant number of Massachusetts residents.

Public use of state forests, parks, wildlife management areas, and other open space translates into direct economic benefits for the state and local communities. Based on a recent national survey, it's been estimated that outdoor recreational visits in Massachusetts result in annual spending of over $1 billion. A survey conducted for DEM's Statewide Comprehensive Outdoor Recreation Plan shows that each of the different categories of open space, from beaches to historic sites to mountains and wetlands, is visited by significant numbers of Massachusetts residents.

As we expand our open space system, we must be vigilant to make sure that we don't lose any of the lands we have already protected. Because public parkland is seen as "free," it can be all too easy to suggest the use of these lands for schools, highways, and other necessary public purposes.

Article 97 of the Massachusetts Constitution gives special protection to parkland by requiring a two-thirds vote by both houses of the legislature before public open space can be used for non-park purposes. Even with this safeguard, citizens and public officials need to ensure that all other alternatives are explored for worthy projects. If there is no other feasible site, the MEPA review process and EOEA's Article 97 Land Disposition Policy require the dedication of compensatory parkland of equal or greater resource value, to ensure there is no net loss of open space.

MAP 8.1:
OUR STATEWIDE OPEN SPACE SYSTEM



Source: MassGIS

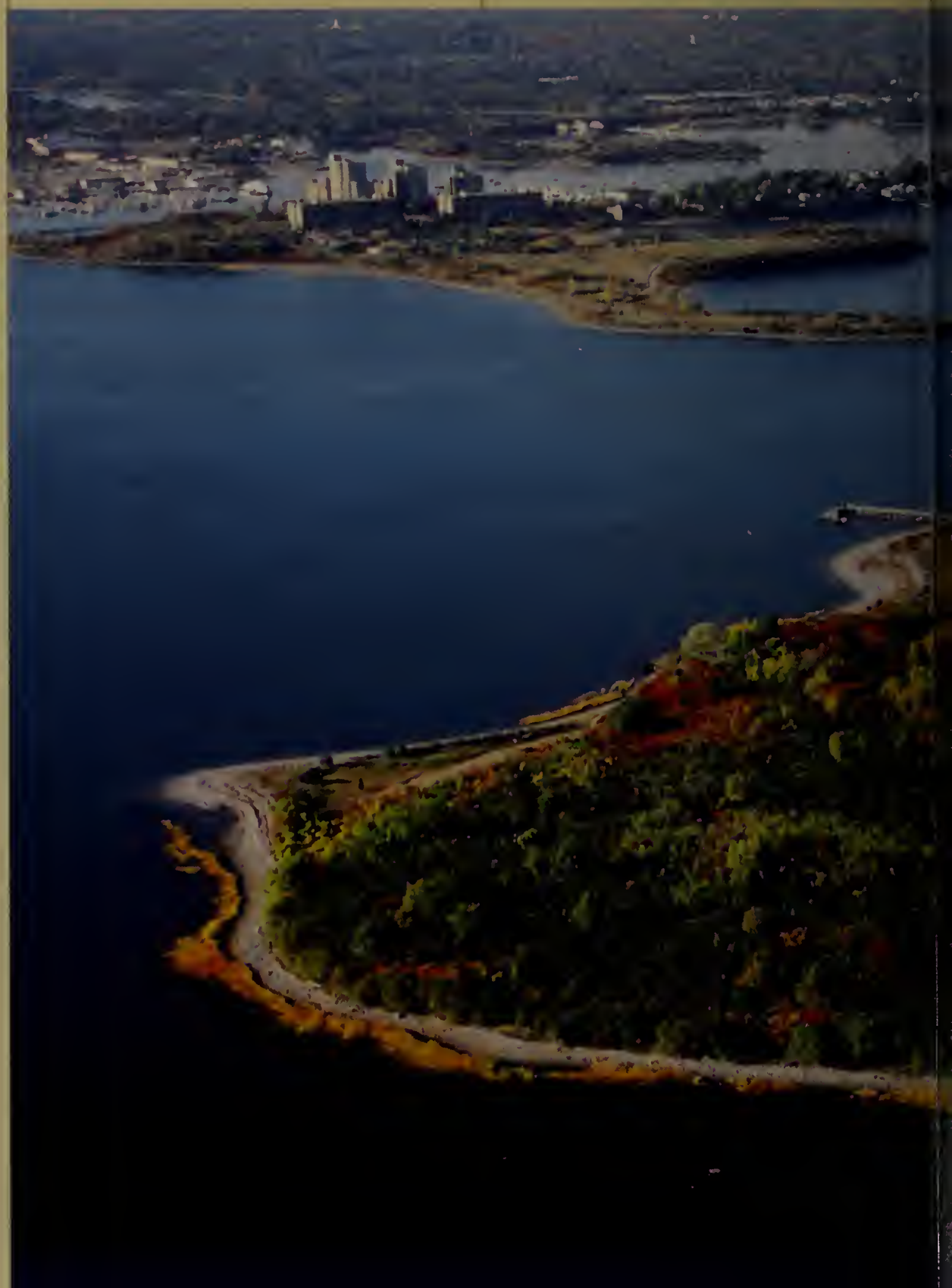
Over one million acres – one-fifth of the state's total area – are permanently protected for conservation and recreational purposes. State agencies manage more than 500,000 acres; municipalities manage more than 325,000 acres; nonprofit conservation groups and land trusts control more than 120,000 acres; the federal government manages 62,000 acres; and private recreational facilities comprise 58,000 acres.

URBAN PARKS AND HARBOR ISLANDS

Urban parks are a crucial element in the statewide open space system. Local parks and playgrounds provide everyone with easy access to the outdoors, whether for active sports or quiet contemplation. As Olmsted envisioned, urban parks function as democratic gathering places where citizens of different ages, classes, and backgrounds can freely meet and mingle.

Both the MDC and DEM play key roles in providing recreational opportunities to underserved urban residents. DEM's urban heritage parks in seven cities preserve and teach the value of historic cityscapes, while swimming pools provide cooling relief from summer heat. The MDC's 17,000 acre urban Metropolitan Parks System comprises some of the most scenic and historic sites in the Boston region, from the Charles River Esplanade to the Blue Hills and Middlesex Fells. The MDC parks system also provides recreational opportunities: beaches such as Revere and Nantasket, more than 20 skating rinks, 19 swimming pools, and numerous ball fields, stadiums, and bicycle and jogging paths. EOEA also provides grants to municipalities to acquire, develop, and restore urban parks.

Because of the heavy demands for use put upon them, urban parks need a higher degree of maintenance. Yet such places have often gone underfunded and neglected. Olmsted's masterpiece, the Emerald Necklace, is about to undergo a $70 million restoration aimed at improving water quality and flood control in the Muddy River and restoring the designs of plantings, bridges, walks, and parkways.



OPEN SPACES FOR CITY DWELLERS

Children play in the Frog Pond on the Boston Common. (Photo: Boston Parks Department/ Elena Houghton)

Besides maintaining and restoring existing urban parks, there are exciting opportunities for new open spaces in and around our cities. The combination of the Boston Harbor cleanup and the Central Artery/ Tunnel (CA/T) project offers the chance to link the Emerald Necklace and the MDC parks into a great green urban ring around the Boston region — a visionary system worthy of Olmsted.

The environmental mitigation commitments for the CA/T involve the creation of a wide range of new open spaces. Spectacle Island, a 160-acre former garbage dump in Boston Harbor, has been capped and landscaped for public use. New parks along both sides of the Charles River will restore public access to the banks of a lost mile of the river. Most dramatic of all, 20 acres of new parks will be created on top of the highway tunnel running through downtown Boston.

Another unique resource is the over 30 islands that comprise the Boston Harbor Islands National Park Area, designated by Congress in 1996. The islands range from fragile wildlife habitats to historic Fort Warren on George's Island and Boston Light, which is the only lighthouse still manned by the U.S. Coast Guard. The park is managed by a partnership of federal, state, local governmental and nonprofit entities, chaired by Environmental Secretary Bob Durand. The partnership will release shortly its long-term management plan for bringing the park to fruition.

A PARK IN THE HARBOR

Grape Island, managed by DEM, is one of over 30 islands that make up the Boston Harbor Islands National Park Area, designated by Congress in 1996. A public-private partnership will shortly release the park management plan. (Photo: ©Kindra Clineff/DEM)

PRIVATE LAND CONSERVATION

Massachusetts has a long and innovative tradition of protecting open space by private organizations and individuals. The Trustees of Reservations, formed in 1891 as the nation's first charitable land trust, preceded the public Metropolitan Parks Commission by two years. Other statewide land preservation organizations include the Massachusetts Audubon Society, The Nature Conservancy, and the Trust for Public Lands. In addition, more local and regional land trusts exist in Massachusetts (over 140) than anywhere else in the United States. Today, nonprofit environmental organizations and land trusts protect more than 120,000 acres – one-eighth of the statewide total.

Private organizations often serve as a "bridge to protection," providing interim funding and legal protection when valuable land is threatened and government is unable to act fast enough. Conservation organizations and land trusts are also brokering innovative protection efforts that pool state, municipal, and private resources.

State law allows property owners to sell or donate permanent voluntary restrictions on the use of their land for conservation, watershed, agricultural, or historic preservation purposes. The restriction is enforced by a government agency or nonprofit. The owner retains fee ownership of the land, while possibly qualifying for tax benefits. Such conservation restrictions (CRs) are a very cost-effective way to expand the open space system, since public dollars go further when an agency is given or buys a CR, compared with purchase of fee ownership.

Chapters 61, 61A, and 61B of the General Laws each lower the local tax rates on land held for forestry, farming, or recreational uses, respectively. The tax abatement reduces the financial pressures on owners to sell for development. This designation also gives municipalities a right of first refusal if the land is offered for sale.

The final element in the state's open space system, private golf courses, ski areas, campgrounds, and other for-profit recreational facilities, currently totals about 58,000 acres.

Another state program, which protects resources of statewide significance at a larger scale, is the designation of an Area of Critical Environmental Concern (ACEC). Local citizens nominate an area for ACEC designation; it is then reviewed for approval by EOEA. Most ACECs have a core of publicly owned land surrounded by an area of mixed public, nonprofit, and private ownership. ACEC designation

PRIVATE LANDS FOR PUBLIC USE

Private lands, such as The Nature Conservancy's Black Pond Bog in Norwell, are an integral part of the state's open space system. Nonprofits control over 120,000 acres of open space statewide (Photo: TNC/Bruce Lund)

requires a higher standard of review and protection under many state environmental regulations, while the development of resource management plans provides a framework to guide future decision-making.

To date, 25 ACECs have been designated, encompassing a total of 170,000 acres. The two largest, the Hockomock Swamp and Parker River ACECs, are each larger than any state park or forest (and are exceeded in size only by the Quabbin Watershed and the Cape Cod National Seashore).

MAP 8.2:
ACECs AND OCEAN SANCTUARIES

Source : MassGIS, MCZM

Twenty-five Areas of Critical Environmental Concern (ACECs) have been designated, comprising more than 170,000 acres. The majority of state waters are protected by law as ocean sanctuaries.

TARGETING OPEN SPACE PROTECTION: THE UPPER CAPE WATER SUPPLY RESERVE

MAP 8.3:
THE UPPER CAPE WATER SUPPLY RESERVE

Source: MassGIS, Cape Cod Commission

The 15,000 acre Reserve is located above the central high point of the aquifer that provides drinking water for the entire upper Cape. Protection of the aquifer is vital, because past actions by the U.S. Army and Air Force have contaminated many wells in neighboring towns.

The designation of the northern 15,000 acres of the Massachusetts Military Reservation (MMR) as the Upper Cape Water Supply Reserve is the most dramatic recent example of state open space protection targeted to support water supply and biodiversity goals. The Reserve is located above the high point of Cape Cod's largest aquifer, which provides all of the drinking water to the neighboring towns of Bourne, Falmouth, Mashpee, and Sandwich. The Reserve contains open grasslands and Cape Cod's largest surviving stretch of its characteristic pitch pine-scrub oak forest, supporting at least 27 state-listed rare animal and plant species.

Starting in the early 1980s, evidence began to emerge of widespread environmental contamination at MMR that had occurred under the previous control of the U.S. Army and Air Force. The dumping of jet fuel, and leachate from the unlined landfill, had created plumes of contamination flowing south from the center of the aquifer that contaminated drinking wells in the neighboring towns. The cleanup of the aquifer is predicted to cost $500 million and take 20 to 25 years.

To replace the lost water supplies, the U.S. Department of Defense is developing a new regional water supply system, drawing on new wells to be drilled into the still pristine northern half of the aquifer. A 21-member Community Working Group (CWG), appointed by EOEA, developed a master plan that recommended permanent protection of the still-undeveloped land above the aquifer.

In October 1999, Governor Cellucci implemented the recommendations of the CWG and issued an Executive Order creating the Reserve. The Reserve will be managed by a three-member environmental commission, comprised of the commissioners of DEM, DFWELE, and the MDC. All other activities, including continued military training by the National Guard that is proven to be compatible with the conservation purposes, will be subject to the commission's oversight.

Another significant success in targeting open space protection is the MDC's land acquisition program in the Wachusett Reservoir watershed. Over the past ten years, the percentage of protected land in this resource, which supplies drinking water to 2.5 million citizens, has increased from 7% to 25%, through the acquisition of 12,000 acres.

THIRTY YEARS AND NINE THOUSAND ACRES LATER, A HEALTHIER RIVER

Perhaps it was growing up in the arid Nevada desert that made Groton resident Marion Stoddart appreciate the environmental value of water when, years later, she settled in the Nashua River watershed.

In the 1960s, the Nashua River was even deemed unsuitable for transporting waste. Noxious fumes from the water would literally peel the paint off houses along its banks.

"It was a commitment I made to myself, to restore the Nashua River and establish a greenway along the river. I wanted to make a difference in the world in my lifetime," Stoddart said. "There was plenty of undeveloped land, and because the river was so filthy, the land was cheap."

Stoddart knew that saving the river depended as much on acquiring land as it did on improving the water quality. But because it was so polluted by paper mills, chemical companies and municipal sewage systems, no agency wanted anything to do with purchasing the land along its banks.

The 1965 passage of the Federal Water Quality Act cleared the way to restore rivers that ran across state lines, like the Nashua.

"We then worked to get the Massachusetts Clean Water Act passed. We wanted to buy land and clean the river at the same time," Stoddart said.

Stoddart helped form an advocacy group, the Nashua River Clean-up Committee, which eventually turned into the Nashua River Watershed Association. The Association has developed a Watershed Management Plan for the 31 communities along the river in Massachusetts and New Hampshire.

Encouraging the purchase of land by government and nonprofit organizations and the placement of conservation restrictions on other parcels, the Association has been able to help protect 9,000 acres along the 90-mile river.

The difference, Stoddart said, is like night and day. Today, you can boat, fish, and even swim in the river and enjoy the pristine serenity of its banks.

A STATEWIDE NETWORK OF GREENWAYS

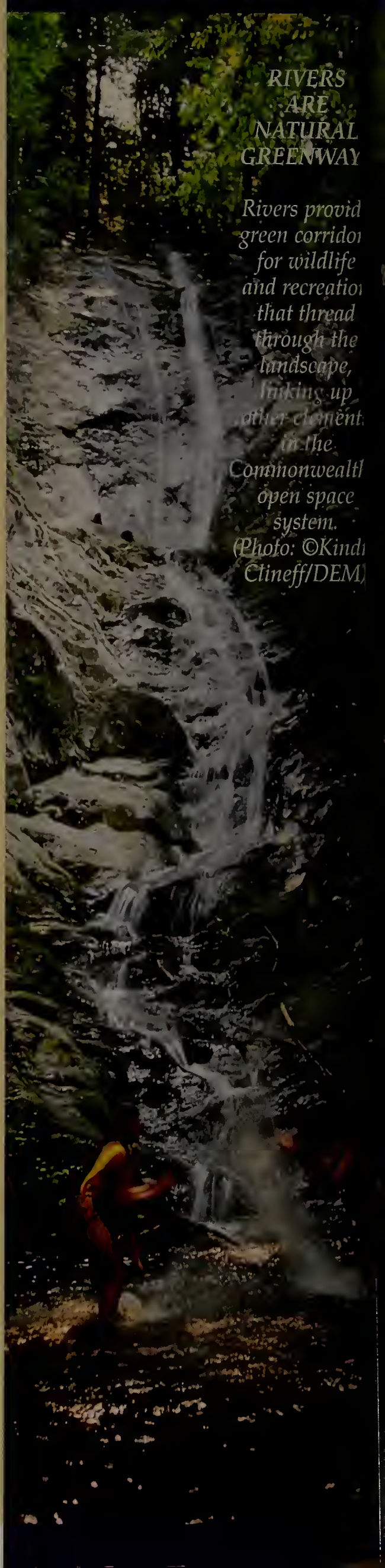
Imagine the Massachusetts landscape laced with ribbons of green space that thread together all the elements of our open space system, from urban parks and playgrounds to historic sites to wilderness areas. Many citizens, local groups, and government agencies are working together to accomplish this vision of a statewide system of greenways. Greenways can play an important role in protecting rivers and other linear ecosystems, or in providing movement corridors for wildlife. Perhaps most important, greenways can make our experience of the outdoors a vital and accessible part of everyday life.

The greenway idea had its genesis in Olmsted's Emerald Necklace. When Olmsted's colleague, Charles Eliot, helped launch the creation of the Metropolitan Parks System, he envisioned a ring of linked green spaces encircling the great urban hub, providing all citydwellers with ready access to nature. In 1921, Benton MacKaye, a farsighted Massachusetts forester and planner, expanded this concept to a national scale when he proposed the two-thousand-mile-long Appalachian Trail, which now runs from Maine to Georgia, crossing western Massachusetts en route.

Today a system of greenways is taking shape at various scales all across the state. Continuous long-distance trails, like the Appalachian Trail and its Massachusetts counterparts, including the Mid-state and Metacomet-Monadnock Trails, allow hikers to experience and understand the larger shapes of the natural landscape. The Bay Circuit Trail, first proposed in 1929 as a great loop running from Newburyport to Duxbury, already provides 145 miles of walkable trails. Local examples are everywhere: from the Housatonic River Walk in Great Barrington to the Minuteman Bikeway in Arlington, Lexington, and Bedford.

Greenway proposals sometimes raise fears about impacts on local property owners. But studies all across the nation have showed that active public use of trails, coupled with easy police access, actually decreases the rate of vandalism and other problems along greenways.

Greenways can exist on the water as well as on the land. A unique addition to DEM's park system is the seventy-mile-long Connecticut River Greenway State Park, extending the length of the river within Massachusetts. The ability to canoe along the river, following the historic routes of Native Americans, fur traders, and lumbermen, knits together approximately 4,000 acres of state lands and another 1,100 acres under permanent conservation easements.



WHAT SHOULD BE DONE

By State Government

- Carry out Governor Cellucci's goal to protect an additional 100,000 acres by 2002 and a total of 200,000 additional acres by 2010.
- Building on the recommendations of the 1998 "Borderland" report, develop a new open space bond bill.
- Target open space acquisition and other protection measures to protect watersheds, biodiversity, historic landscapes, and working farms and forests.
- Preserve, revitalize and expand urban parks, including the Boston Harbor Islands, the New Charles River Basin Parks, the new Central Artery parks, and the Metropolitan Park System.
- Pass the Community Preservation Act to provide funds for local land protection efforts.
- Urge Congress to reauthorize the Land and Water Conservation Fund.
- Strengthen Article 97 protections.
- Inventory public lands not protected by Article 97.
- Make broader use of ACECs to develop protection and management strategies for larger areas and regions.

By Local Governments

- Adopt or update community-wide open space plans.
- Coordinate infrastructure investments in roads, sewers, and schools with open space priorities.
- Establish a local land bank, if authorized under the proposed Community Preservation Act.
- Purchase tax title land for public open space.
- Modify local zoning to encourage open space (cluster) developments.

By Business

- Use cluster development patterns to maximize open space preservation in new projects.
- Permanently protect undeveloped open space through conservation restrictions.

By Citizens

- Join your local land trust or state park "friends group."
- Consider placing a conservation restriction on undeveloped property, or donating land to state, municipal or nonprofit land organizations.

State Environmental Agencies

Executive Office of Environmental Affairs (EOEA)
EOEA directs and coordinates all state policies aimed at preserving, protecting and regulating the natural resources and the environmental integrity of the Commonwealth. EOEA is headed by the Secretary of Environmental Affairs, who is a member of the Governor's cabinet. EOEA also includes the Office of Coastal Zone Management (MCZM), the Office of Technical Assistance (OTA), and the Massachusetts Environmental Policy Act (MEPA) Office. Contact:
EOEA
251 Causeway Street
Boston, MA 02114
(617) 626-1000
www.state.ma.us/envir

In addition to the Secretary's office, there are five separate departments in EOEA, each headed by a commissioner who reports to the Secretary:

Department of Environmental Management (DEM)
DEM oversees the natural, cultural, and historic resources within state forests, parks, recreation facilities, public lands and waters. DEM directly manages over 278,000 acres of land; and it enhances the quality of these resources through statewide resource planning protection, and regulatory programs. Contact:
DEM
251 Causeway Street
Boston, MA 02114
(617) 626-1250
1-800-831-0569
www.magnet.state.ma.us/dem/dem.htm

Department of Environmental Protection (DEP)
DEP is responsible for ensuring clean air and water, the safe management and disposal of solid and hazardous wastes, the timely cleanup of hazardous waste sites and spills, and the preservation of wetlands and coastal resources. Contact:
DEP
1 Winter Street
Boston, MA 02108
(617) 292-5000
Infoline: 1-800-462-0444 or (617) 338-2255 from Boston area
www.magnet.state.ma.us/dep

Regional Offices:
Western Regional Service Center, Springfield: (413) 784-1100 x214
Central Regional Service Center, Worcester: (508) 792-7683
Northeast Regional Service Center, Woburn: (617) 932-7677
Southeast Regional Service Center, Lakeville: (508) 946-2714

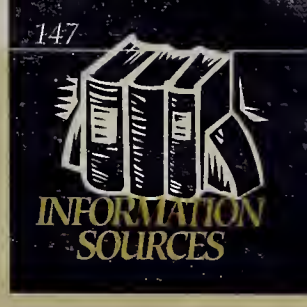
Department of Fisheries, Wildlife and Environmental Law Enforcement (DFWELE)
DFWELE is charged with stewardship responsibility over marine and freshwater fisheries, wildlife species, plants and natural communities. DFWELE directly manages 78,000 acres of land. It also enforces all environmental laws relating to fishing, hunting, hazardous waste, illegal dumping, boating and recreational vehicles. Contact:
DFWELE
251 Causeway Street
Boston, MA 02114
(617) 626-1590
www.state.ma.us/dfwele/dfw

Department of Food and Agriculture (DFA)
DFA supports, promotes and enhances the long-term viability of Massachusetts agriculture for the benefit of the state's economy and environment. Contact:
DFA
251 Causeway Street
Boston, MA 02114
(617) 626-1700
www.massdfa.org

Metropolitan District Commission (MDC)
The MDC is a multi-service agency responsible for the management of the 17,000 acre Boston Metropolitan Parks System, a watershed and reservoir system that provides pure water for 2.5 million people in the MWRA service area, and 700 miles of parkways. Contact:
MDC
20 Somerset Street
Boston, MA 02108
(617) 727-5114
www.state.ma.us/mdc/

Massachusetts Water Resource Authority (MWRA)
The MWRA is a Massachusetts public authority established by an act of the Legislature in 1984 to provide wholesale water and sewer services to 2.5 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities. Contact:
MWRA
Charleston Navy Yard
100 First Ave.
Boston, MA 02129
(617) 242-6000
www.mwra.state.ma.us

Massachusets Historical Commission (MHC)
The MHC administers state and federal preservation programs, including historic preservation planning (such as maintaining the State Register of Historic Places), review and compliance (including implementation of Section 106 of the National Historic Preservation Act), grant assistance, and public information activities. The MHC is also the office of the state archaeologist. Contact:
MHC
220 Morrissey Boulevard
Boston, MA 02125
(617) 727-8470
www.state.ma.us/sec/mhc/



Federal Environmental Agencies

Environmental Protection Agency (EPA)
The mission of the EPA is to protect human health and to safeguard the natural environment — air, water, and land — upon which life depends. Contact:
EPA Region 1
1 Congress Street
Boston, MA 02114
1-888-372-7341
www.epa.gov/region01

National Park Service (NPS)
The NPS preserves unimpaired the natural and cultural resources and values of the National Park System of the United States, comprising 378 areas covering more than 83 million acres throughout the nation. Contact:
NPS
U.S. Custom House
200 Chestnut Street, 5th Floor
Philadelphia, PA 19106
(215) 597-7013
www.nps.gov

U.S. Fish & Wildlife Service
The Service manages the 93-million acre National Wildlife Refuge System comprised of more than 500 national wildlife refuges, thousands of small wetlands, and other special management areas. It also enforces Federal wildlife laws, protects endangered species, manages migratory birds, restores nationally significant fisheries, and conserves and restores wildlife habitat such as wetlands. Contact:
FWS
300 Westgate Center Drive
Hadley, MA 01035
(413)253-8200
www.fws.gov

Non-Governmental Associations

Alternatives for Communities and Environment (ACE)
ACE works to achieve environmental justice and solve environmental and public health problems by providing legal and technical support, educational programs, and organizing assistance to community groups throughout New England. Contact:
ACE
2343 Washington Street, 2nd Floor
Roxbury, MA 02119
(617)442-3343
www.netcom.com/~psloh

Appalachian Mountain Club (AMC)
The Appalachian Mountain Club promotes the protection, enjoyment, and wise use of the mountains, rivers and trails of the Northeast. Contact:
AMC
5 Joy Street
Boston, MA 02108
(617) 523-0636
www.outdoors.org

Conservation Law Foundation (CLF)
The Conservation Law Foundation is a New England-based nonprofit environmental advocacy organization, with a staff of 25 professional advocates – attorneys, scientists, economists, and policy experts. Contact:
CLF
62 Summer Street
Boston, MA 02110
(617) 350-0990
www.clf.org

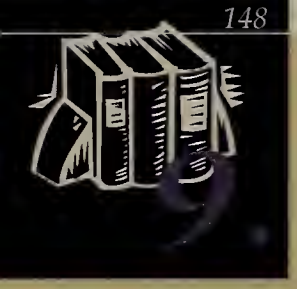
Environmental League of Massachusetts (ELM)
ELM is an independent, member-based, nonprofit organization established 100 years ago as the Massachusetts Forestry Association. ELM's research, watchdog, and education work reflects the full range of modern environmental issues: pollution, waste disposal and recycling, biodiversity, and toxics. Contact:
ELM
3 Joy Street
Boston, MA 02108
(617) 742-2553
www.envrionmentalleague.org

Massachusetts Association of Conservation Commissions (MACC)
MACC provide educational programs, a regular newsletter and numerous publications to keep Conservation Commissioners current on relevant environmental law, science and policy. Contact:
MACC
10 Juniper Road
Belmont, MA 02178
(617) 489-3930
www.macc1@ma.ultranet.com

Massachusetts Audubon Society (MAS)
The Massachusetts Audubon Society maintains 37 wildlife sanctuaries that are open to the public, protects more than 28,000 acres of conservation land in Massachusetts, conducts educational programs for nearly 150,000 school children each year, and advocates for sound environmental policies at the local, state, and federal levels. Contact:
Massachusetts Audubon Society
208 South Great Road
Lincoln, MA 01773
1-800-AUDUBON
www.massaudubon.org

Massachusetts Public Interest Research Group (MASSPIRG)
MASSPIRG is a nonprofit, nonpartisan organization dedicated to serving as a watchdog for the state's citizens and environment, with citizen members and a staff of policy specialists. Contact:
MASSPIRG
29 Temple Street
Boston, MA 02111
(617) 292-4800
www.masspirg.org/masspirg

Masachusetts Watershed Coalition
The Massachusetts Watershed Coalition is a network of organizations committed to the protection, management and enhancement of Massachusetts' rivers and watershed ecosystems. Contact:
Massachusetts Watershed Coalition
12 Mt. Pleasant Avenue
Leominster, MA 01453
(978)534-0379
www.ma.ultranet.com/~mwc/contact.html



Museum of Science
The Museum provides science and technology education and programs to individuals, families, and children in New England and around the world. Contact:
Museum of Science
Science Park
Boston, MA 02114
(617) 723-2500
www.mos.org

The Nature Conservancy (TNC)
The mission of The Nature Conservancy is to preserve plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need for survival. Contact:
The Nature Conservancy
205 Portland Street, Suite 400
Boston, MA 02114
(617) 227-7017
www.tnc.org

New England Aquarium
The mission of the New England Aquarium is to promote, present, and protect the world of water through exhibits, research, conservation, and education. Contact:
New England Aquarium
Central Wharf
Boston, MA 02110
(617) 973-5200
www.neaq.org

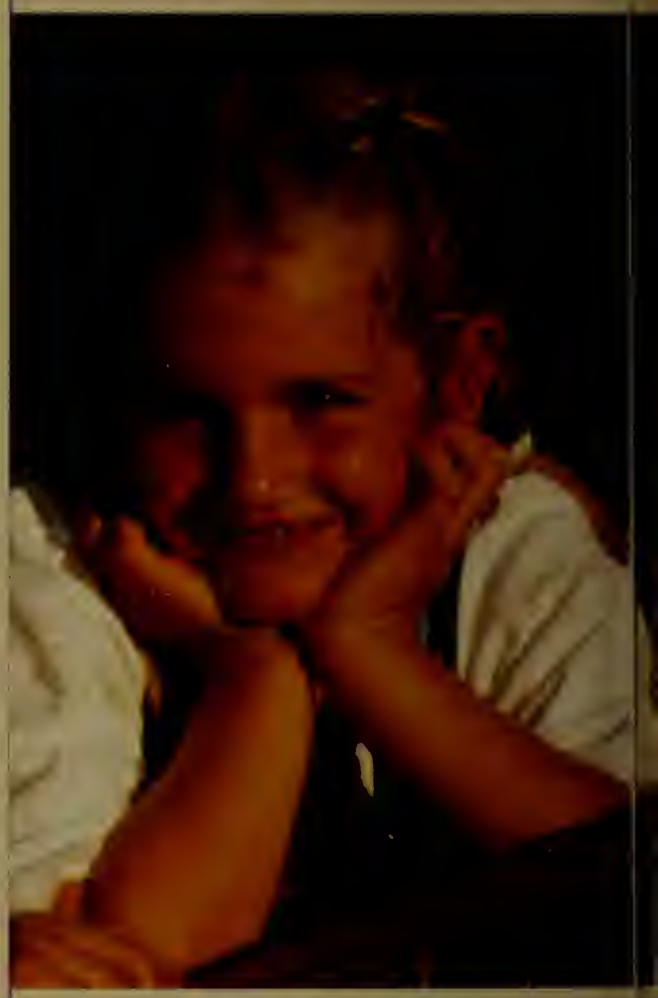
Sierra Club
The Sierra Club promotes conservation of the natural environment by influencing public policy decisions – legislative, administrative, legal, and electoral.
Contact:
The Sierra Club
100 Boylston Street
Boston, MA 02116
(617) 423-5775
www.sierraclubmass.org

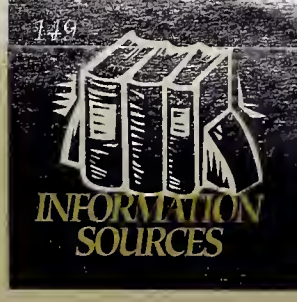
The Trustees of Reservations (TTOR)
The Trustees preserve, for public use and enjoyment, landscapes of exceptional scenic, historic, and ecological value in Massachusetts and protect special places across the state. Contact:
The Trustees of Reservations
Long Hill, 572 Essex Street
Beverly, MA 01915
(978) 921-1944
www.ttor.org

Trust for Public Lands (TPL)
The Trust for Public Lands works with private landowners, government agencies and community groups to protect land for recreation and conservation purposes.
Contact:
Trust for Public Lands
33 Union Street, 4th Floor
Boston, MA 02108
www.tpl.org
(617) 367-6200

Union of Concerned Scientists (UCS)
The Union of Concerned Scientists is an independent nonprofit alliance of citizens and scientists across the country. Its core groups of scientists and engineers collaborate on technical studies regarding renewable energy options, the impacts of global warming, the risks of genetically engineered crops, and other related topics.
Contact:
Union of Concerned Scientists
2 Brattle Square
Cambridge, MA 02238
(617) 547-5552
www.ucsusa.org/resources/index.html

The Watershed Institute
The mission of The Watershed Institute is to protect and restore urban ecosystems through education, research and outreach.
Contact:
The Watershed Institute
Boston College
163 Higgins Hall
Chestnut Hill, MA 02467
(617) 868-2762
www.bc.edu/watershed





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